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FM 3-15

DEPARTMENT OF THE ARMY FIELD MANUAL

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NUCLEAR ACCIDENT CONTAMINATION CONTROL



**HEADQUARTERS, DEPARTMENT OF THE ARMY
JUNE 1966**

TAGO 7092A



FIELD MANUAL

No. 3-15

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 17 June 1966

NUCLEAR ACCIDENT CONTAMINATION CONTROL

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SECTION I

INTRODUCTION

1. Purpose

This manual provides guidance for training, equipping, and utilizing emergency teams for nuclear accident radiological contamination control. Specific guidance is provided for CBR Alpha and Radiological Control (RADCON) Teams, but the general principles presented apply to all special teams and personnel concerned with nuclear accident control.

2. Scope

a. This manual covers procedures and techniques for reducing radiation hazards resulting from nuclear accidents and the control procedures applicable in relatively small areas that contain hazardous levels of radiological contamination. It describes procedures and practices for detecting, identifying, measuring, controlling, and decontaminating radiological contamination and specifies the levels of radiological contamination that are significant both

during recovery operations and after decontamination at a nuclear accident site. FM 3-12 and TM 5-225 outline the procedures that are applicable to large areas of radiological contamination.

b. This manual is designed primarily for peacetime operations. It is also applicable in wartime except that in nuclear warfare, alpha contamination is not considered militarily significant.

3. Changes

Users of this manual are encouraged to submit recommended changes or comments to improve the manual. Comments should be keyed to the specific page, paragraph, and line of the text in which the change is recommended. Reasons should be provided for each comment to insure understanding and complete evaluation. Comments should be forwarded direct to Commandant, U.S. Army Chemical Center and School, Fort McClellan, Ala., 36201.

SECTION II

RESPONSIBILITIES

4. General

a. Primary command responsibility for control of an accident rests with the service or agency having physical possession of the weapon at the time of the accident. However, joint agreement between the Departments of the Army, Navy, and Air Force and the Atomic Energy Commission assigns the Army the primary responsibility for minimizing the hazardous effects of accidents involving weapons of other services or agencies until the responsible service or agency can assume control of the scene.

b. Command jurisdiction of a nuclear accident site involving a weapon under Department of the Army (DA) control is normally the responsibility of the commander of the army area in which the accident occurs unless precluded by a specific directive of the Department of Defense.

c. Command of the accident site is initially assumed by the commander of the military installation at or nearest the scene of the accident and is subsequently assumed by a designated Army Area Representative (AAR) upon his arrival at the site. If the accident occurs on a military installation, activity, or missile site, the AAR will command only those emergency forces provided by United States Continental Army Command (USCONARC) commands and will render maximum assistance to the responsible commander. Where areas of possible hazard extend outside the boundaries of the military installation, activity, or missile site, the AAR will command all activities outside the boundaries.

d. If an accident involves nuclear material in transit outside a military installation, command of the site is assumed initially by the duly appointed courier officer pending arrival of the commander of the nearest military installation,

or his representative, or the Explosive Ordnance Disposal (EOD) Team. The designated AAR assumes responsibility upon his arrival. If the accident is of a domestic emergency nature, primary command responsibility for control will rest with the Department of the Army (Joint Department of the Army, Navy, and Air Force and Atomic Energy Commission Agreement). Therefore, supporting plans must include provisions to meet this contingency.

e. A command SOP for nuclear accident/incident control should be prepared by units which are, or may become, involved with nuclear weapons. Appendix II may be used as a guide.

5. Continental United States (CONUS)

a. Headquarters, USCONARC, is responsible for DA implementation of nuclear accident and incident control plans in the CONUS and USCONARC agencies. While certain CONUS elements, U.S. Army Air Defense Command (USARADCOM) and U.S. Army Materiel Command (USAMC), are responsible for implementing nuclear accident and incident control plans at installations under their respective commands, USCONARC retains primary responsibility for controlling the effects of occurrences outside such installations. The fact that many agencies, both military and civilian, are involved, and that an incident may become an accident, requires detailed coordination between commands. Plans must be prepared and operations must be conducted in such a manner that response capabilities provide maximum effectiveness in preventing or reducing casualties and damage. In transit accidents or incidents may occur, and responsibility for the shipment concerned must be clearly defined and understood. During shipment, the weapon is considered to be in the custody of DA when the Army courier officer signs the courier receipt

form for the weapon from a consignor of another service or agency. Conversely, the nuclear weapon leaves DA custody when a consignee of another service or agency signs a receipt for the weapon from the courier officer at the transfer point.

b. The Commanding General, U.S. Army Materiel Command, provides Radiological Control (RADCON) Teams which furnish technical advice and assistance to responsible commanders upon request (sec V).

c. The Surgeon General provides Radiological Emergency Medical Teams (REMT) upon request in accordance with AR 40-13.

d. The Commanding Generals, U.S. Army Materiel Command and U.S. Army Air Defense Command, are responsible for implementation of nuclear accident and incident control plans, including the submission of reports within their respective commands (AR 385-40 and Army Strategic Capability Plan (ASCP)).

e. The Army, Navy, Air Force, Defense Atomic Support Agency (DASA), Atomic Energy Commission (AEC), and other Federal agencies may request assistance from the Joint Nuclear Accident Coordinating Center (JNACC) at any time. JNACC acts as a centralized agency for coordinating assistance and information concerning accidents involving nuclear weapons and all types of radiological accidents and incidents. JNACC maintains current information on the location and capability of specialized Department of Defense (DOD) or AEC teams capable of responding to accidents involving nuclear weapons. Such teams are then required to respond to the request from JNACC for assistance, subject to command and operational limitations. JNACC is manned continuously and can be reached by calling Sandia Base, Albuquerque, N. M., area code 505, telephone number 264-8279, or SCAN, Sandia Base, extension 8279.

SECTION III

NUCLEAR ACCIDENT HAZARDS

6. General

a. A nuclear accident is an unexpected event involving a nuclear weapon, utilization facility, or component of either that results in any of the following situations:

- (1) Loss of, or serious damage to, the weapon or components so as to render it unsafe or nonoperational.
- (2) Nuclear or nonnuclear explosion of the weapon or facility.
- (3) Radioactive contamination.
- (4) Public hazard.

b. Although nuclear weapons are designed to preclude a nuclear yield in the event of accidents, the high explosives and the radioactive fissionable material in themselves constitute a potential hazard. The precautions taken against these hazards are more than sufficient for the control of hazards from other components such as explosive fuels.

7. Hazards

a. *High Explosives.* All nuclear weapons contain conventional high explosives. These high explosives constitute the major hazard involving nuclear weapons in an accident. If the high explosive becomes ignited, it will burn or perhaps explode. Detonation and fires that occur during shipment or storage of nuclear weapons must be treated in accordance with the provisions of TM 5-315.

b. *Radioactive Fissionable Material.*

- (1) *Plutonium.* Plutonium is a heavy metal which when first processed looks like stainless steel but which rapidly oxidizes to a characteristic brownish-black color. When associated with a fire, plutonium may burn, producing radioactive fumes. Detonation of the high-explosive component may pulver-

ize plutonium into minute, invisible particles that are dispersed in smoke and dust which can cause contamination over a large area. Plutonium in a pulverized form is flammable. Deposits of pulverized plutonium produced when an accident occurs may be re-suspended by natural forces, such as the wind, or by vehicles and low-flying aircraft operating in the area. Air sampling is necessary to properly evaluate the hazard caused by airborne radioactive particles. The plutonium referred to throughout this manual is plutonium-239. Plutonium-239 (Pu^{239}) (Plutonium-239 may be abbreviated Pu^{239} or ^{239}Pu . The abbreviation Pu^{239} will be used throughout this manual.) is primarily an alpha radiation emitter.

- (a) The primary hazard of plutonium is from inhalation of particles suspended in the air. Of 100 particles of plutonium oxide inhaled, approximately 25 are exhaled immediately. About 50 are deposited in the upper respiratory tract and are swallowed or expectorated within several days. Of 25 particles deposited in the lower respiratory tract, 15 are removed from the lungs at a rate governed by a 120-day biological half-life. (The time required for the body to eliminate one-half of an administered dose of any substance by regular processes of elimination.) Ten are absorbed into the bloodstream. Seven of these are deposited in the skeletal system and may produce cancer or bone diseases many years later. Table I is a guide to the type of respiratory protection rec-

ommended in areas where airborne alpha contamination is encountered. If airborne alpha contamination is suspected but the concentration is unknown, the level of 100,000 dpm/m³ should be assumed and a self-contained breathing apparatus worn until the extent of the hazard has been definitely established.

- (b) Plutonium entering the bloodstream through deep wounds presents a serious hazard even though it is a slow process. Hazards are practically negligible from absorption of plutonium through the skin and/or from shallow wounds.

- (2) *Uranium.* Uranium when first processed looks like stainless steel, but it slowly oxidizes to a golden color and then to a characteristic blue-black or black color. Since uranium does not burn as easily as plutonium, there is less likelihood of a contaminated smoke hazard. There is a greater likelihood that large pieces of metallic uranium will be scattered at the scene of an accident. The smaller pieces may burn, however, and cause some airborne hazard. Inhalation is the primary means of entry of uranium into the body. In cases of accidents involving uranium contamination, a 90-percent efficient respirator (M17 or M9A1 protective mask) for 10-micron and larger size particles normally will provide sufficient protection. In areas with contamination over 100,000 dpm/m³, a situation may be encountered where a self-contained breathing apparatus (ABC-M15A1 or M20) would be required for sufficient protection. In this instance, the toxic hazard from heavy metal poisoning must also be considered. For advice on heavy metal poisoning, consult medical personnel.

- (3) *Fission products.* Should a nuclear weapon or device involved in an accident result in a partial nuclear yield, there will be a beta-gamma hazard from the fission products as well as an alpha hazard from unfissioned uranium or plutonium. The short range and

low penetrating ability of beta particles cause them to constitute a limited external hazard. They can produce skin burns and are a significant internal hazard. Conversely, the much greater range and higher penetrating ability of gamma radiation present an important external hazard, and its presence or absence must be determined.

Table I. Recommended Respiratory Protection Against Airborne Alpha Contamination

Exposure level (Alpha disintegration)	Respiratory protection for short-term exposure*
0 to 100 dpm/m ³ -----	No respiratory protection.
100 to 10,000 dpm/m ³ ---	High-filtration respirator at least 99% efficient (such as the M9A1 protective mask).
100 to 100,000 dpm/m ³ --	High-filtration respirator at least 99.9% efficient (such as the ABC-M17 protective mask or the M9A1 protective mask with the M14 biological and radiological particulate canister).
Greater than above ----- levels.	Self-contained breathing apparatus.

* Short-term exposure is defined as no more than several working days per month.

8. Significant Levels of Contamination

The significant hazardous levels of ground radiological contamination that have been established for a nuclear accident are as follows:

a. Beta-gamma radiation—10 millirad per hour (10 mrad/hr). It should be emphasized that large scale beta-gamma contamination will result only from a nuclear, or partial nuclear, detonation. Since our weapons are designed to preclude an accidental nuclear detonation, this occurrence will be extremely rare. A chunk of plutonium spread by a high-explosive detonation may produce a dose rate as high as 50 mrad/hr at the source. This should be considered a "hot spot" rather than general beta-gamma contamination.

b. Alpha radiation—1,000 micrograms of plutonium-239 per square meter (1,000 $\mu\text{g Pu}^{239}/\text{m}^2$). However, any concentration higher than 10 micrograms of plutonium-239 per square meter for alpha radiation may produce a seri-

ous resuspension problem. Plutonium-239 is assumed in all cases of alpha contamination because it constitutes the greatest internal hazard. For significant hazardous levels of airborne alpha contamination, see table I.

9. Protective Measures

a. If alpha contamination is suspected, respirators, protective masks, or, if necessary, self-contained breathing apparatus will be worn when approaching the accident site. The site should be approached from upwind, and visible concentration of dust or smoke should be avoided.

b. Eating, drinking, chewing, and smoking will not be permitted in the contaminated area. Smoking material and foodstuff will not be carried into the contaminated area.

c. Protection should be afforded to cuts or breaks in the skin to minimize the possibility of internal contamination.

d. Military uniforms, civilian clothing, or any garments that cover the body are suitable for contamination control operations. Disposable items such as coveralls, gloves, and boot covers should be worn to facilitate personnel decontamination.

e. To prevent resuspension of hazardous material, all aircraft, in particular rotary wing types, should stay clear of the contaminated area.

f. All personnel will enter and leave the possible contamination area through the established control points (hot line). While in the area, avoid unnecessary contact with possible contaminated surfaces (debris, shrubbery, puddles, etc.).

g. Prior to entry into the possible contamination area, all clothing and equipment will be checked to insure they are in order (para 41). A final check will be made at the hot line by the hot line monitor (para 42).

SECTION IV

ALPHA TEAM

10. General

A CBR Alpha Team is a CBR team with the additional capability and responsibility for alpha monitoring. As used in this manual, Alpha Team will be understood to refer to these special teams with an alpha monitoring capability.

11. Mission

The mission of the Alpha Team is to—

a. Detect and identify radiological contamination resulting from an accident.

b. Report the presence of radiological contamination immediately upon detection to the AAR or, in his absence, to the senior officer present. Recommend that a RADCON Team (sec V) be called if any alpha or if significant beta-gamma contamination is detected.

c. Mark the 1,000 $\mu\text{g Pu}^{239}/\text{m}^2$ contour line if alpha radiation is detected (para 44).

d. Mark the 10 mrad/hr contour line if beta-gamma radiation is detected (para 44).

e. Mark the exclusion perimeter. If both alpha and gamma radiation are detected, the exclusion perimeter will be a combination of contours as determined in c and d above, using the contour farthest from the accident site.

f. Provide security for any nuclear weapon components if the team is first to arrive at a nuclear accident site.

g. Perform other duties as assigned by the AAR.

12. Organization

The Alpha Team should consist of a minimum of one officer and four enlisted men, all qualified in the detection, identification, and measurement of radioactivity and having a general knowledge of the decontamination and

health physics aspects of radioactivity. At least two of the enlisted men should be qualified driver/radio operators. Two monitors per Alpha Team are the minimum requirement.

a. The team leader will coordinate the activities of the Alpha Team with other emergency teams at the accident site and furnish advice on radiological monitoring and survey procedures and emergency decontamination measures for personnel (pending arrival of the RADCON Team).

b. All monitors will be qualified to perform alpha, beta, and gamma radiation monitoring.

c. All team members will have a minimum security clearance of SECRET.

13. Equipment

See paragraph 19.

14. Training

See section VI.

15. Utilization

a. Major commands with an area nuclear accident/incident control responsibility will organize, train, and position sufficient Alpha Teams so as to insure arrival of a team at the scene of the nuclear accident or significant nuclear incident within 4 hours after notification of the team. Waivers of this requirement for isolated areas may be granted by major commanders. During each movement involving a complete nuclear weapon or nuclear component, an Alpha Team will be on standby status in the army area of responsibility. The most expeditious mode of transportation will be immediately available to move the team to an accident site. After notification of a nuclear accident, the alerted team should be able to depart to a local assembly area, prepared to perform its mission, within 30 minutes during duty

hours and within 1 hour during off-duty hours. Once an alerted Alpha Team has been committed, other teams from the army area should be placed on standby to be used for backup or in support of other nuclear weapon shipments.

b. Upon arriving at the accident site, the team will report immediately to the AAR or his representative and then coordinate with other emergency teams present. In the event the Alpha Team is the first to arrive at the accident site, the team leader will assume the responsibility of directing emergency actions until properly relieved. If radiological contamination is detected, the contaminated area will be marked and controlled; a RADCON Team will be requested by the AAR. The Alpha Team will remain at the site to furnish advice and special assistance to the AAR. Upon arrival of the RADCON Team, the Alpha Team, if directed by the AAR, will assist the RADCON Team.

c. After coordination with other emergency teams, the Alpha Team will monitor for radiological contamination. Detection of any radiation above normal background will be reported immediately. The Alpha Team will then con-

spicuously mark the location of the 10 mrad/hr beta-gamma contour line and/or the 1,000 $\mu\text{g Pu}^{239}/\text{m}^2$ level for alpha contamination, and record the data. Unit conversion factors necessary in evaluating alpha contamination are contained in section VII. Contamination markers (fig. 15) attached to stakes should be used to mark the contaminated area.

d. The Alpha Team or other teams as designated by the AAR must ascertain the names and locations of all individuals and the identity of any animals that were in the immediate vicinity of the accident for possible legal and medical reasons. All personnel and animals should be monitored, decontaminated if necessary, and referred to the RADCON Team or the Radiological Emergency Medical Team for further tests. When monitoring civilian personnel, monitors should be careful not to alarm or frighten them unnecessarily. Control of the area to preclude reentry of unauthorized personnel or animals should be established.

e. Relationships with news media personnel will be as prescribed in AR 360-5 and AR 360-43.

SECTION V

RADIOLOGICAL CONTROL (RADCON) TEAM

16. General

A RADCON Team is a special radiological team that is organized to provide technical assistance and advice to the AAR in radiological emergencies.

17. Mission

The mission of the RADCON Team is to—

- a. Perform a detailed radiological survey for alpha and beta-gamma radiation (sec IX).
- b. Control and supervise waste disposal measures (sec XII).
- c. Provide health physics services.
- d. Control and supervise radiological safety services.
- e. Supervise and provide technical advice for decontamination operations (sec X).
- f. Provide technical advice to the AAR on all radiological aspects of the accident.
- g. Supervise and provide technical advice for the control and containment of the radiological contamination at an accident site (sec VIII).

18. Organization

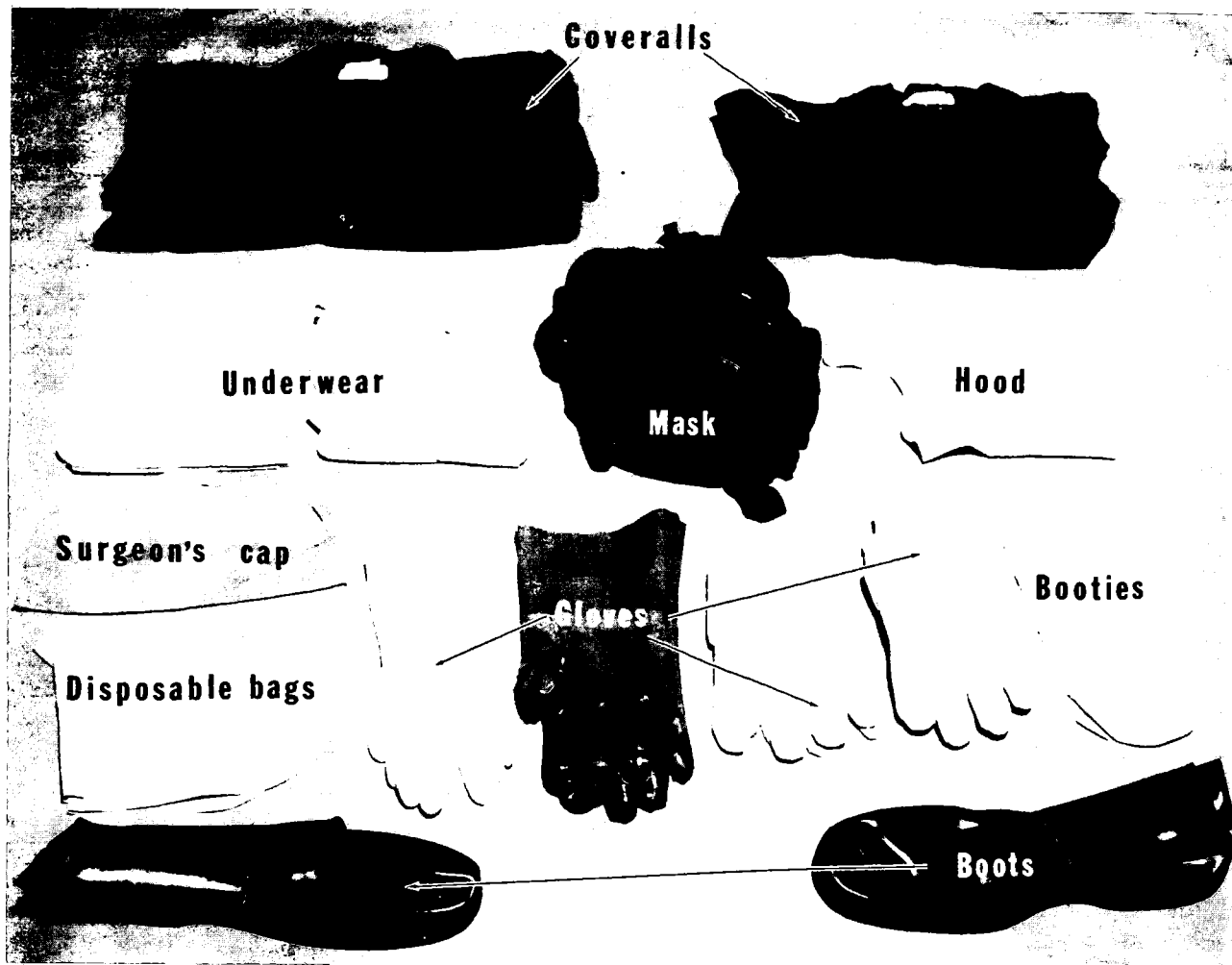
The RADCON Team will consist of a minimum of a team leader and eight other individuals all of whom are qualified in radiological monitoring for alpha, beta, and gamma radiation and in air sampling. In addition, they will be qualified to perform the duties described in *a* through *h* below. All team members will have a minimum security clearance of SECRET.

a. The team leader should be a Nuclear Effects Engineer (MOS 7330) or an equally qualified officer. He must have a detailed knowledge of nuclear weapon accident potentials and the associated hazards. He should be qualified in radiological safety and nuclear emergency team operations. The team leader will coordinate the

activities of the RADCON Team with other emergency teams and the AAR at the accident site. He is responsible for the training and readiness of the team at all times, to include supervising the calibration and maintenance of all radiac equipment. He should be designated as a Class A agent and authorized to purchase supplemental equipment and supplies necessary to accomplish the team's assigned mission in the field. The team leader, together with a medical representative, will certify that the contamination has been reduced to an acceptable level (para 53 and 54) for release of the area after operations have been completed.

b. The health physicist will be an individual trained in the protection of personnel from the hazardous effects of radiation. This includes a knowledge of shielding requirements, dose calculations, maximum permissible limits of exposure, and sampling and evaluation techniques for air, water, and ground contamination. He will provide all dosimetry services for the team and other personnel as directed by the team leader. He will maintain complete exposure records as outlined in AR 40-14 and Title 10, Code of Federal Regulations, Part 20. The health physicist will advise the team leader on health physics matters and interpretation of the data obtained.

c. The laboratory technician will be an individual trained in radiochemistry laboratory procedures and techniques and qualified to perform radiological laboratory analyses of samples, to include quantitative alpha determinations. He will be qualified in sampling techniques for air, water, and surface samples, and in evaluation of the data obtained. He will maintain all necessary laboratory data and records related to samples and analyses. In addition, he will be capable of acting as assistant to the health physicist when directed by the team leader.



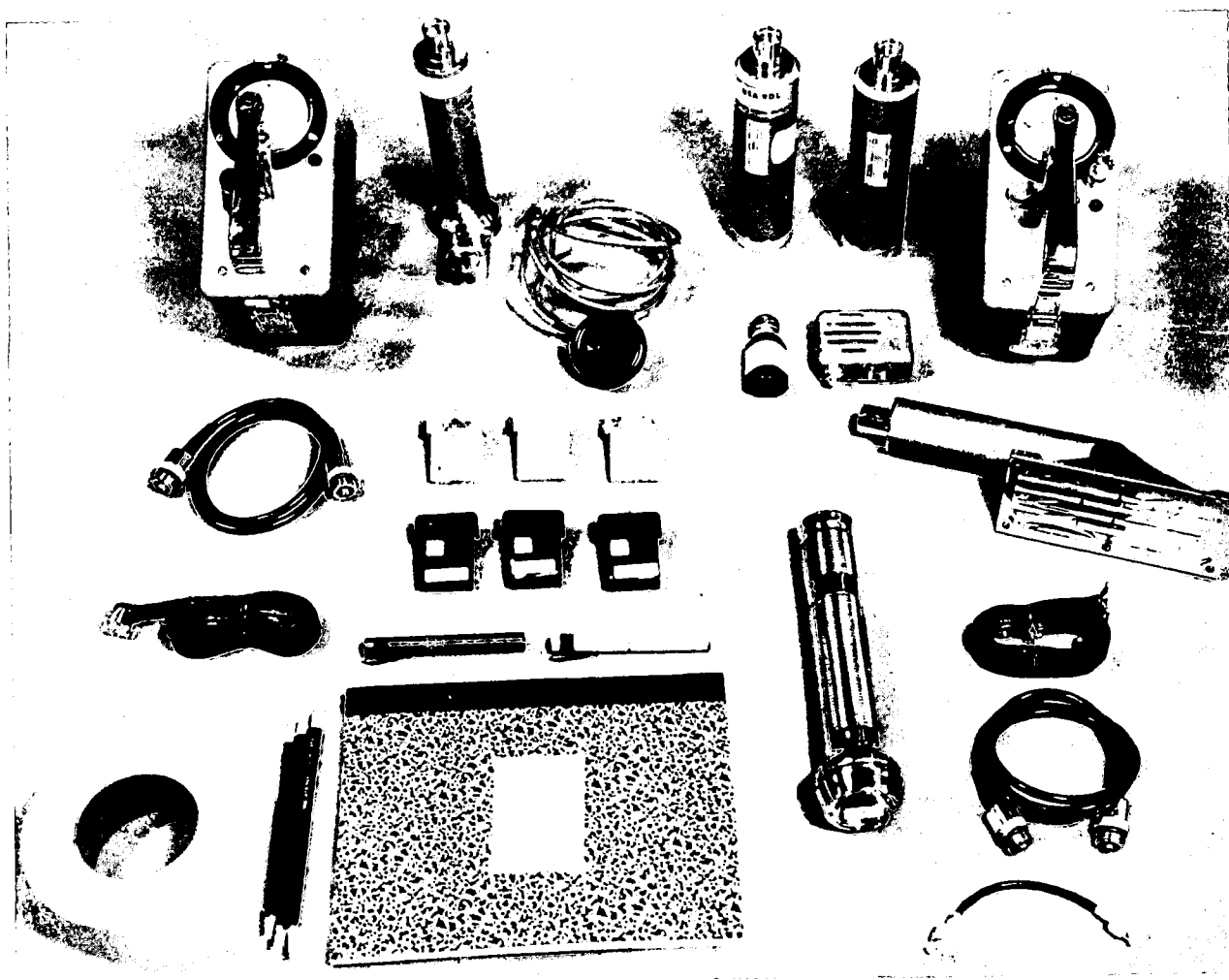
1 Anticontamination clothing
 Figure 1. Sample flyaway kit components.

d. The equipment specialist will be an individual qualified to operate, check, and make limited field repairs on all types of radiacmeters and air samplers used by the team. His functions will be to store, control, issue, and maintain all the electronic equipment in possession of the team at the accident site. Further, he will check the radiac equipment, using appropriate check sources, and calibrate the alpha instruments using the AN/UDM-6. He will maintain all records on the equipment in accordance with TM 38-750 and other pertinent publications. In addition, the equipment specialist will maintain two complete flyaway kits (fig. 1) ready to move at all times.

e. The decontamination specialist will be an

individual qualified to advise the team leader on all aspects of radiological decontamination of personnel, equipment, facilities, and large areas (fig. 2). He will be qualified in shielding requirements, waste disposal procedures, and shipping requirements for radioactive waste. He will set up the hot line (para 42) and supervise the establishment and operation of the personnel and equipment decontamination stations.

f. The two monitors will be qualified to perform alpha, beta, and gamma monitoring, to install and operate air samplers (fig. 3), to take other samples as required, and to assist in the monitoring duties (fig. 4) at the hot line and decontamination station. In addition, they will be proficient in decontamination procedures



2 Monitoring and dosimetry equipment
Figure 1.—Continued.

and will assist the decontamination specialist when directed by the team leader.

g. The technical recorder or administrative specialist will be qualified to record the technical data gathered at the accident site. He will be familiar with the reports and records required and be qualified to write and keep all journal type reports. He will maintain the

operational logs, maps, and other information of value for history, safety studies, legal use, or for other purposes. He must be capable of operating cameras and other equipment possessed by the team for record purposes. He will be familiar with regulations and policies covering the release of information and should be qualified to handle the public information



*Figure 2. Use of special vacuum cleaner for
area decontamination.*



Figure 3. Operation of air sample by monitor wearing self-contained breathing apparatus.



Figure 4. Use of the alpha floor and road monitor.

releases. He should be designated as purchasing agent to enable him to make supplemental purchases authorized by the team leader in the field.

h. The assistant team leader will perform the duties of the team leader in his absence. At a nuclear accident site he will direct the operation of the hot line, decontamination facilities, establishment of air sampling stations, and all monitoring activities. He will prepare and maintain a current plot of the levels of contamination at the accident site. He must be proficient in the preparation and use of overlays.

19. Equipment

The equipment listed in table II represents the minimum required to accomplish the assigned missions of the Alpha and RADCON Teams. For extended operations, both teams will require additional support. The AAR will request this support from the nearest military installation. The request may include, but is not limited to, messing facilities, quartering facilities, power generators, communication equipment, and additional personnel. The Alpha and RADCON Team equipment lists should be kept as small as possible consistent with accomplishment of their missions. Both teams must maintain a high degree of mobility so that they may be responsive to any radiological emergency.

Table II. Suggested Equipment for Alpha and RADCON Teams¹

Item No.	Item	Quantity	
		Alpha Team	RADCON Team
A. DETECTION AND IDENTIFICATION EQUIPMENT			
1	Radiac set AN/PDR-60 ² (FSN 6665-965-1516) -----	2	4
2	Radiac set AN/PDR-27J (FSN 6665-543-1435) ³ -----	2	4
3	Gamma radiacmeter AN/PDR-43D (FSN 6665-738-5867) -----	----	2
4	Tritium monitor (Atomic Model, TSM-91-B or T290A or equivalent) ---	----	1
5	Repair parts and extra batteries for radiacmeters -----	As required	As required
6	Air sampler, high-volume, 24v dc, with filter holders and filters (example: TF1A-4 Staplex) -----	----	2
7	Air sampler, high-volume, 110v, ac, with filter holders and filters (example: TF1A-27 Staplex) -----	----	4
8	Tripod mounts for air samplers -----	----	6

See footnotes at end of table.

Item No.	Item	Quantity	
		Alpha Team	RADCON Team
9	Gamma radiacmeter (Eberline Model Gadora 1 or 1B, or equivalent) ----	----	2
10	Alpha floor monitor (Eberline Model FM-3G or equivalent) ----	----	1
11	Scintillation alpha counter (Eberline Model SAC-3 or equivalent) ----	----	1
12	Millipore filter counter (Eberline Model SPA-1 or equivalent) ----	----	1
13	Proportional counter (Eberline Model AC-4 or equivalent) ----	----	1
14	Anemometer, ML-433A/PM (FSN 6660-663-8090) ----	----	1
15	Calibrator, radiac, AN/UDM-6 (FSN 6665-767-7497) ----	----	1

B. DOSIMETRY AND HEALTH PHYSICS EQUIPMENT

16	Pocket dosimeter, IM-9E/PD ⁴ (0-200 mrad) (FSN 6665-705-6068) ----	2 per mbr	30
17	Pocket dosimeter, IM-147/PD ⁴ (0-50 rad) (FSN 6665-542-0729) ----	2 per mbr	30
18	Pocket dosimeter, IM-93 ⁴ (0-600 rad) (FSN 6665-530-1210) ----	2	30
19	Radiac detector charger PP-1578A/PD (FSN 6665-542-1177) or Bendix Model 906-2 ----	2	5
20	Film badges (beta-gamma) ----	1 per mbr	2 per mbr
21	Replacement film for film badges ----	----	As required
22	Film badges (neutron) ----	----	10
23	Nose and surface swipes, kit: ⁵ ----	1	1
	Swabs, chemical agents sampling, type 1, (FSN 6665-170-5499) ----		1,000 each.
	Paper swipes, nose, w/stick ----		1,000 each.
	Applicator, wood, cotton tip (1/2 in. x 6 in.) (FSN 6165-303-8250) ----		1,000 each.
	Test tube, 10 ml (for use with cotton and paper swipes) 50 each.		
	Plastic envelope (1/2 in. x 3 in.), for use with cotton and paper swipes) ----		1,000 each.
	Paper separators (each holds 10 papers for surface swipes) ----		1,000 each.
24	Soil sampling kit: ----	----	1
	Broom, whisk, straw, 8 in., (FSN 7920-292-4364) ----		2 each.
	Knife, putty, 1 in. x 6 in., (FSN 5120-221-1336) ----		2 each.
	Bottle, wide-mouth, screw-cap, 210 ml, (FSN 8125-408-9125) ----		20 each
25	Sampling portion of water testing kit, poisons, M4A1, or equivalent ----	----	1
26	Replacement parts for sampling equipment ----	----	As required
27	Counter, scaler (Hamner Model N-221, nuclear Chicago 2586 or equivalent) ----	----	1

C. COMMUNICATIONS EQUIPMENT⁶

28	AN/PRC-6 radio (or similar type) (FSN 5820-194-9928) ----	3	4
29	Spare batteries ----	As required	As required
30	AN/PRC-25 radio (or similar type) (FSN 5820-857-0759) ----	----	1
31	Spare batteries ----	----	As required
32	Telephone set, TA-312 (FSN 5805-543-0012) or equivalent ----	----	4
33	Wire, WD1/TT ----	----	As required

D. ELECTRONIC REPAIR EQUIPMENT

34	Tool kit, electronic repair ----	----	1
35	Meter, volt-ohm ----	----	1
36	Repair parts, electronic equipment, kit ----	----	1
37	Replacement parts for instruments ----	----	As required

See footnotes at end of table.

Item No.	Item	Quantity	
		Alpha Team	RADCON Team
E. MARKING EQUIPMENT			
38	Tape, textile, white, herringbone weave, (engineer tape) ¾ in. wide, ft.	5000	3000
39	Radiation hazard marking signs, w/stakes -----	As required	As required
40	Grease pencils, assorted colors -----	As required	As required
F. DECONTAMINATION EQUIPMENT			
41	Personnel decontamination kit (soap, towels, brushes, brooms, etc.) -----	1 per mbr	1 per mbr
42	Portable vacuum cleaner, American Vacuum Company, ARCO Model 52 or equivalent, with attachment kit No. 505A with absolute filter unit No. 5C 1802 -----	----	1
43	Masking tape 1-, 2, and 3-in. widths -----	As required	As required
G. PROTECTIVE EQUIPMENT			
44	Boot covers, cloth or plastic, pr -----	1 per mbr	3 per mbr
45	Coveralls, plastic disposable, pr -----	----	As required
46	Coveralls, cloth, pr -----	2 per mbr	3 per mbr
47	Gloves, cloth or canvas, pr -----	2 per mbr	3 per mbr
48	Gloves, surgeon's, pr -----	1 per mbr	6 per mbr
49	Cap, surgeon's -----	2 per mbr	3 per mbr
50	Hood, cotton cloth -----	----	3 per mbr
51	Protective mask, M17 (or similar type) -----	1 per mbr	2 per mbr
52	Masking tape, 3 in., rolls -----	4	As required
53	Breathing apparatus self-contained M20 (MSA or equivalent) -----	----	4
54	Replacement bottles for self-contained breathing apparatus -----	----	As required
H. INDIVIDUAL EQUIPMENT'			
55	First-aid packet, individual -----	1 per mbr	1 per mbr
56	Lensatic compass -----	2	4
57	Canteen -----	1 per mbr	1 per mbr
58	Pistol belt -----	1 per mbr	1 per mbr
59	Poncho (or raingear) -----	1 per mbr	1 per mbr
60	Clipboard -----	2	8
61	Flashlight, w/batteries -----	1 per mbr	1 per mbr
62	Entrenching tool -----	1 per mbr	1 per mbr
I. ADMINISTRATIVE EQUIPMENT AND SUPPLIES ⁶			
63	Notebook -----	2	2
64	Roadmaps of areas of responsibility -----	2	2
65	Paper, pencils, blank forms, maps, overlay paper, acetate, press release forms -----	As required	As required
66	Camera -----	----	1
J. MISCELLANEOUS EQUIPMENT			
67	Plastic bags, large (30 gal. drum size) -----	10	500
68	Plastic bags, medium -----	10	1000
69	Plastic bags, small -----	----	1000
70	Footlockers -----	As required	As required
71	Binoculars, M13A1, 6 x 30 (or equivalent) -----	----	2
72	Pistol, caliber 0.45 -----	1 per team	1 per team

¹ Based on team strengths cited in this manual.

² IM-166 ()/PD will be placed by Alpha Radiacmeter IM-170/PD (radiac set AN/PDR-60) with plutonium-gamma probe as the latter becomes available for issue.

³ Models A through H are standard C items; models J, L, P, and Q are standard A and have the same operating characteristics and procedures.

⁴ The RADCON Team should have at least 10 extra dosimeters of each type for use of the AAR, VIP's, firefighters, and others.

⁵ Cotton-tipped swabs for beta-gamma emitters; paper for alpha emitters. Kits may be fabricated locally; components may be procured from commercial sources.

⁶ Depending upon local situations and conditions, the team mission may be expedited by the addition of one AN/VRC-8 radio (or similar type) per Alpha or RADCON Team.

⁷ Personal clothing and sundry requirements should support team members for 1 week without resupply. Individual and unit clothing and equipment cited herein are for technical mission use. Clothing should be adequate for the terrain and weather in which the teams are employed.

⁸ Toll tickets and Bell System and POL credit cards are recommended also when and where feasible.

20. Training

See section VI.

21. Utilization

a. If a nuclear accident occurs, a RADCON Team will be immediately placed on alert status by the commander having control over the RADCON Teams. If any alpha or significant beta-gamma contamination is involved, the services of a RADCON Team will be requested by the fastest means of communication available with an immediate precedence. Within CONUS, RADCON Teams are available upon request of the AAR from the Commanding General, U. S. Army Materiel Command. Requests for RADCON Teams may be dispatched by message directly to the Commanding Officer, U. S. Army Nuclear Defense Laboratory, Edgewood Arsenal, Md. Requests may be made by telephone to Edgewood Arsenal, Md., area code 301, telephone number 676-1000, or SCAN 231-1360, extensions 26248 or 23121 during duty hours (0745 to 1615 hours Eastern Time), or extensions 22203 or 21137 after duty hours. The USCONARC Emergency Operations Center, Fort Monroe, Va. (telephone extension 2256 or SCAN 231-3672), is prepared to relay requests if the AAR desires to go through USCONARC for assistance. Any request for assistance should include as much of the following information as available.

- (1) Name, location, and phone number of the person requesting the assistance; i. e., the AAR.
- (2) Type of accident, such as weapon, reactor, or other. In weapon accidents the proper code name should be given.
- (3) Location of the accident site and coordinating instructions for leading the team to the control point, if required.

- (4) Type of radiation (alpha, beta, or gamma), extent of area, and levels of contamination if known.
- (5) Type of surface involved, such as open field, roadway, or buildings.
- (6) In case of accidents involving shipments of radioactive materials, the types of radioisotopes involved, if known.
- (7) Location of nearest airfield.

b. Upon receipt of a movement order, the RADCON Team will be en route within 4 hours. The team will travel by air or surface transportation, whichever provides the most expeditious means. If the entire team cannot be en route within 4 hours, an advance party consisting of a minimum of the team leader and one monitor will be en route within 4 hours. The remainder of the team, under the command of the assistant team leader, will proceed as soon as possible after the advance party so as to arrive within 24 hours after receipt of the movement order.

c. Upon arrival at the accident site, the team leader will report to the AAR for instructions. If not already accomplished by the Alpha Team, the RADCON Team will determine the degree and extent of radiological contamination. The team will secure the names of all individuals and ascertain the identity of any animals involved in the accident and determine their present location. Decontamination of personnel, animals, and equipment will be accomplished within physical limitations. Cleanup and contamination control measures taken by augmentation personnel with equipment obtained from adjacent military installations will be supervised by the RADCON Team. The Alpha Team can provide additional specialist assistance if requested. Section X contains decontamination details.

SECTION VI

RECOMMENDED TRAINING PROGRAM FOR ALPHA AND RADCON TEAMS

22. General

The training program recommended for team training is based on the assumption that each member of a team has received individual training at the appropriate service school; therefore, the program is designed to train the members to function as a team. This training should be conducted in conjunction with the training of other emergency teams. Some suggested sources of formal individual training are given in table III.

23. RADCON Team

a. All members will be trained in alpha and beta-gamma monitoring and in sampling techniques to include air sampling.

b. Training to qualify individual team members in their assigned functions will be conducted periodically to insure proficiency. Each member of the team should be cross-trained in

an alternate position whenever possible. See table III for formal individual training courses.

24. Alpha Team

a. In addition to the CBR training program, an alpha monitoring course consisting of a minimum of 5 hours will be presented to designated Alpha Teams by their team leaders. This course is outlined in table IV.

b. See Table III for formal individual training courses appropriate for the Alpha Team members.

25. Test Alerts

Periodic test alerts are required to determine that individuals are adequately trained in all operational phases. See appropriate Army Nuclear Accident/Incident Control Plan (NAICP) for details.

Table III. Formal Individual Training Courses

Team member	Course title, number, and length	Location
AAR Alpha Team	Nuclear Emergency Team Exercise (NETEX) (1 week)	Field Command, DASA, Sandia Base, N.M.
RADCON Team leader Alpha Team leader	Nuclear Emergency Team Operation (4 weeks)	Atomic Weapons Training Group, Field Command, DASA, Sandia Base, N.M.
RADCON Team leader Health physicist	Radiological Safety, 7K-F3 (2 weeks)	U.S. Army Chemical Center and School, Fort McClellan, Ala.
RADCON Team leader Health physicist	Occupational Radiation Protection, 212 (2 weeks)	Dept of Health, Education and Welfare, Public Health Service
RADCON Team leader Alpha Team leader	Management of Radiation Accidents, 235 (1 week)	Do.
Alpha Team leader Laboratory technician	Basic Radiological Health, 211 (2 weeks)	Do.
Laboratory technician Decontamination specialist	Measurement of Airborne Radioactivity (2 weeks)	Do.

Table III. Formal Individual Training Courses—Continued

Team member	Course title, number, and length	Location
Laboratory technician Decontamination specialist	Environmental Radiation Surveillance, 224 (3 weeks)	Do.
Equipment specialist	Radiac Instrument Repair (4 weeks)	U.S. Navy, Treasure Island, Calif. U.S. Army Southeastern Signal, Center and School, Fort Gordon, Ga.

Table IV. Alpha Team Training

Period	Hours	Subject	Scope	References
1	1	Orientation -----	Definition of terms and description of nuclear accident and incident control plan (NAICP) in army basic plan concerned. Discussion of where the team fits into the NAICP and the duties of team members.	FM 3-15; NAICP of pertinent army basic plan.
2	1	Procedures and Protection; Hazards of Alpha Radiation.	Procedures and problems concerning alpha radiation. Protection against hazards. Basic science of alpha radiation.	FM 3-15; TM 5-225; TM 11-6665-207-12; TM 11-6665-221-15.
3	1	Alpha Survey Meters and Survey Techniques.	Familiarization with standard alpha instruments. Characteristics, controls, operation, nomenclature, use, functioning, and maintenance.	Do.
4	1	Control Procedures and Site Operations.	Procedures for establishment and operation of the hot line, decontamination station, and air sampling stations; data collection procedures.	Do.
5	1	Procedures and Protection for Alpha Monitoring.	Procedures and problems concerning the monitoring of alpha radiation. Techniques of alpha monitoring. Protection against hazards; protective clothing and equipment.	Do.

SECTION VII

ALPHA MONITORING TECHNIQUES

26. General

a. The alpha particle is a relatively large, doubly positive charged, highly ionizing nuclear particle with a short range in matter. Alpha particles are always emitted with definite discrete energies from a parent nucleus. Plutonium-239 emits a 5.15-Mev alpha particle which travels about 4 centimeters in air. An alpha particle is, by nature, a helium nucleus. Alpha particles are emitted in all directions from their source and travel in straight lines. Energy is lost by interactions with air or other molecules. With their energy expended, forward progress stops. Two free electrons are attracted by the double positive charge and a helium atom is formed. The alpha particle is no longer detectable.

b. The principal alpha emitters contained in nuclear weapons are uranium (U^{235} , U^{238}) and plutonium (Pu^{239}). All three easily become airborne and can be inhaled. Plutonium is the most dangerous because it is the greatest internal hazard. To safeside, all measurements of alpha contamination will be considered in terms of plutonium-239.

c. The maximum range in air of alpha particles depends on their energy. Under standards conditions, the maximum range in air of alpha particles from Pu^{239} is 4 centimeters. Liquids, such as water, and solids, such as paper or animal tissue, will reduce this range by a factor of about a thousand. For example, a Pu^{239} alpha particle will penetrate about 0.004 centimeter of paper.

d. Considering all these facts, it is readily apparent that alpha contamination may be exceedingly difficult to detect under some conditions even though the detecting instrument works perfectly. Additional factors concerning actual monitoring are discussed in paragraph 28b.

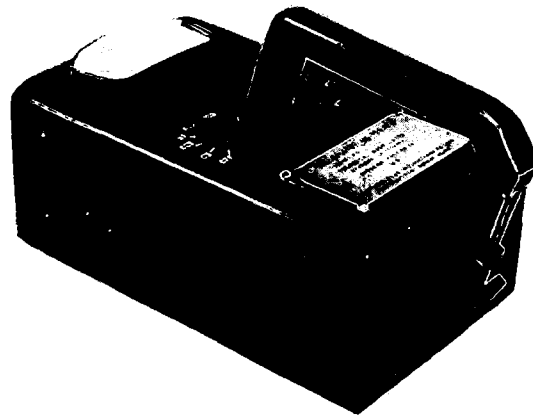


Figure 5. IM-156()/PD radiacmeter.

27. Radiac Equipment

a. *Alpha Radiacmeters.* The detecting chamber in alpha instruments is basically the same as that used in any radiac instrument, except that one side is covered by a very thin mylar film that allows alpha particles to enter the chamber. The following instruments are the standard alpha radiac sets:

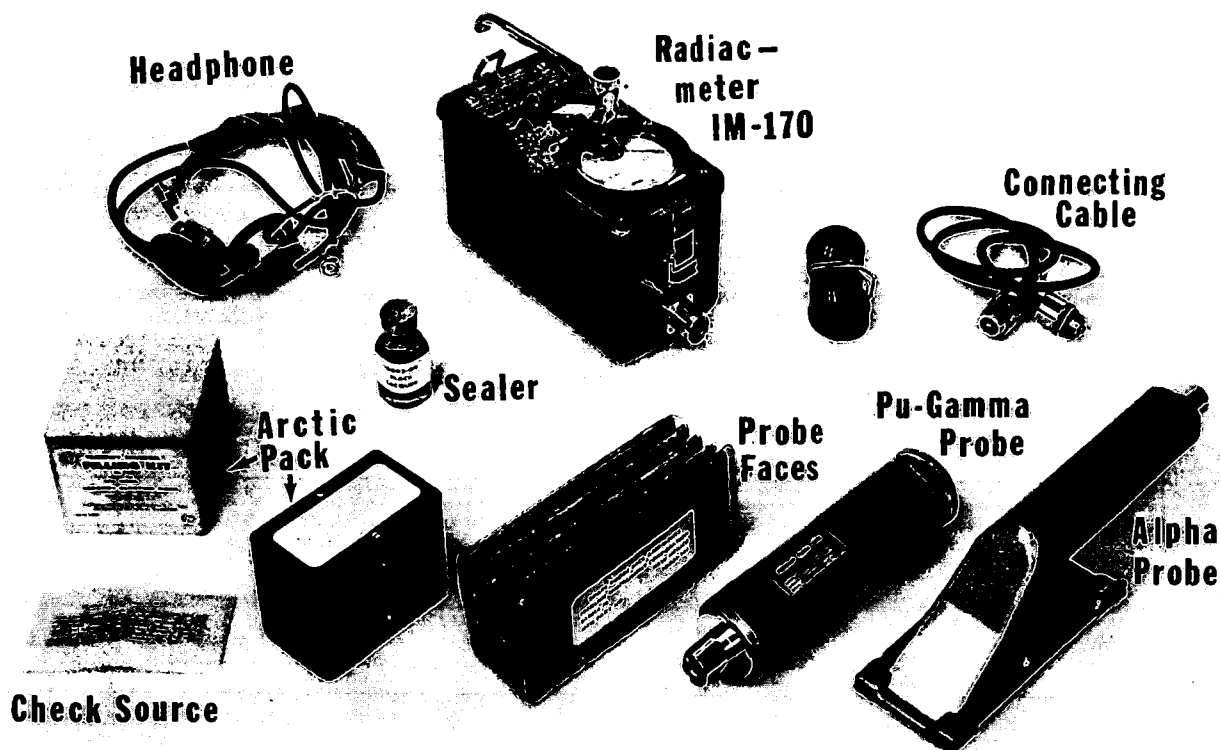
- (1) IM-156()/PD (JUNO SRJ-6) (fig. 5). This ion chamber instrument will detect alpha, beta, gamma, and X-radiation, but it has been procured for the purpose of detecting and measuring alpha radiation. This radiacmeter normally will be used for detecting alpha radiation. For detailed information, see TM 11-6665-207-12 on the AN/PDR-53 radiac set of which the IM-156()/PD was formerly a component. The IM-156()/PD is a standard C item. It is calibrated by the TS-1230A radiac calibrator. For details, see TB 3-6665-202-12.



1 Set shown in carrying case
 Figure 6. AN/PDR-60 radiac set.

- (2) AN/PDR-54 (IM-154/PD) (EBERLINE PAC-3G). This proportional instrument is capable of measuring only alpha radiation. The radiacmeter IM-154/PD is capable of detecting up to 2,000,000 counts per minute (cpm) using the X20 shield. For detailed information, see TM 11-6665-208-15. It is a standard C alpha survey radiacmeter. The AN/PDR-54 is calibrated by the AN/UDM-6 radiac calibrator; see TB 3-6665-203-12.
- (3) AN/PDR-60 (IM-170/PD) (fig. 6). The AN/PDR-60 radiac set consists

of the IM-170/PD (Eberline PAC-1SAGA) radiacmeter which is a portable alpha-measuring and gamma-detecting device utilizing two external probes and an internal Geiger-Mueller (G-M) detector. Using the G-M detector, high energy gamma monitoring is possible up to 2 rad/hr. With the alpha probe (AC-3), the meter can detect up to 2,000,000 cpm. The alpha probe uses a zinc sulfide silver activated scintillator for measuring alpha in the presence of limited beta and gamma radiation. The alpha probe can



2 Components of the AN/PDR-60 radiac set
Figure 6.—Continued.

be calibrated on all four scales using the AN/UDM-6 radiac calibrator; see TB 3-6665-203-12. This radiacmeter is shown in figure 7. See TM 11-6665-221-15. The plutonium gamma probe (PG-1) uses a NaI (Tl) scintillation crystal for detecting the low energy gamma rays (17 Kev) associated with Pu^{239} . The AN/PDR-60 is the standard A alpha monitoring radiac set.

b. Beta-Gamma Radiacmeters. The following instruments are the standard beta-gamma survey radiac sets:

- (1) *IM-174/PD.* This ion chamber instrument measures high dose rates of gamma radiation only. For detailed instructions, see TM 11-6665-213-12.
- (2) *AN/PDR-27J (IM-141/PD).* This Geiger-Mueller instrument is capable of measuring low dose rates of gamma and of detecting beta radiation. For

detailed instructions, see TM 11-6665-209-15.

- (3) *IM-170/PD (PAC-1SAGA).* Although this is primarily an alpha instrument, it does have the capability of detecting the presence of gamma radiation up to 2 rad/hr ($\alpha(3)$ above).

28. Monitoring Procedures

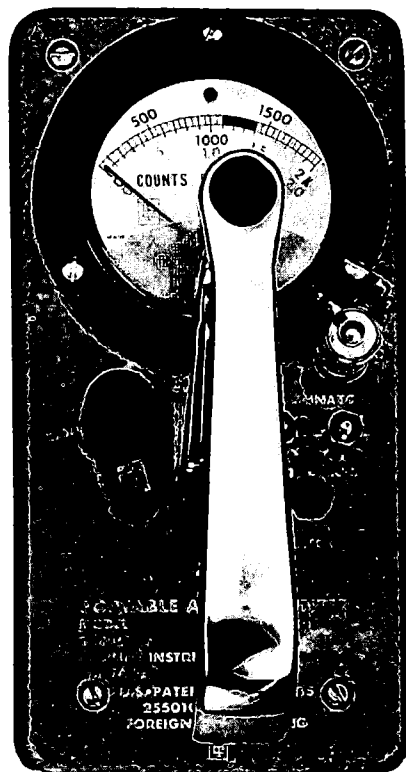
a. Beta-gamma. The monitors should check for the presence of beta-gamma radiation prior to and while monitoring for alpha radiation.

b. Alpha. Several factors are to be considered when using alpha radiacmeters, such as the IM-170/PD (PAC-1SAGA).

- (1) *General.* Alpha radiation is very difficult to detect. This is almost entirely due to the low energy and extremely short range of the emitted alpha particles. Alpha instruments must be



(a) Handle displaced



(b) Handle in place

Figure 7. IM-170/PD alpha radiacmeter.

placed within 4 centimeters of the contaminated surface before they will detect any alpha radiation. This makes alpha monitoring a slow, tedious, and physically tiring process. The range of alpha particles is decreased considerably by liquids or solids. A wet surface, resulting from rain, dew on the ground, or from firefighting (a distinct possibility at a nuclear accident site), cannot be monitored successfully using the alpha probe of any instrument. Dust settling over the contaminated area can prevent a correct reading. The PG-1 probe of the IM-170/PD radiacmeter can be used effectively under these conditions to detect the presence of Pu^{239} , but other

means must be used to determine the level of alpha contamination. The surface itself must be considered. On a rough surface such as plowed ground, clothing, or rough concrete, the alpha contamination settles in depressions and crevices in the surface. The alpha particles subsequently emitted are shielded by the surface itself and may not be detected by an instrument no matter how close the instrument is to the surface. Correction factors for various surfaces have been obtained from tests and are discussed in paragraph 29. In addition to the above considerations, the window over the detector of the radiacmeter must be very thin in order for alpha particles

to enter the detector and be detected. These windows are extremely fragile and great care must be taken to prevent puncturing when placing the probe near or on the ground.

(2) *Meter reading interpretation.*

- (a) To take a reading, the probe should be placed in contact with the surface being monitored.

Caution: The probe face is very thin and extremely fragile. Set the probe down gently and do not place it down on any sharp object, such as grass stubble or rocks, which might puncture the thin window.

On grassy surfaces, the back of the probe may be used to push the grass aside and the probe face lowered to the surface by a rolling motion of the probe (fig. 8). Placing the probe on the surface insures consist-

ent results even though the probe face might become contaminated. In most instances any contamination will be a small percentage of the total reading and can either be neglected or subtracted from the succeeding surface readings. If the probe contamination reading is large compared to the surface reading, the probe must be decontaminated. A damp cloth wiped very gently across the probe face or the use of a soft brush (camel's hair) will reduce the contamination considerably in most cases.

Caution: Unless extreme care is used in brushing the probe face, minute pinholes will be placed in the mylar window. These holes are difficult to find and to patch.

On dry, powdery surfaces where large amounts of probe contamina-

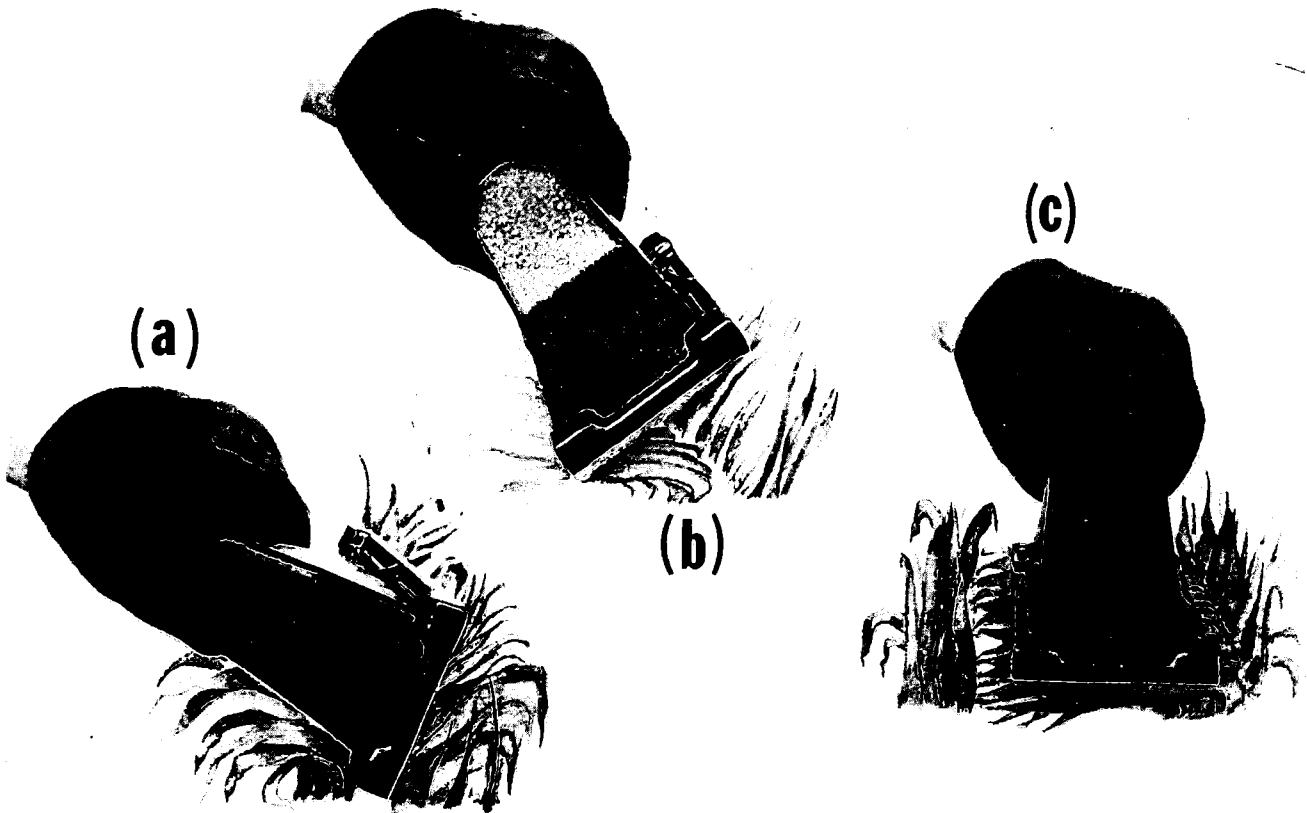


Figure 8. Positioning of probe on grassy surface.

tion would result if the probe touched the surface, a 1/8-inch block may be taped to each end of the probe. This will insure a constant probe height above the surface when readings are taken. This will also reduce the instances of probe puncture. If the blocks are permanently attached to the probe and the instrument calibrated in this configuration, there will be no appreciable decrease in correctness of readings. If the blocks are not permanently attached, the instrument must be recalibrated with the blocks in place or a correction otherwise made.

- (b) To obtain a representative reading for a particular point, several readings should be taken on and around the point. After each of these readings, the probe should be lifted off the surface and the meter checked to see if any contamination resulted. If so, the contamination readings may be subtracted from the succeeding reading. Record the highest of these corrected readings as the reading for the point in question.
- (c) An accuracy figure for any alpha radiacmeter cannot be specified because any measurement will vary considerably, depending on the energy of the emitted alpha particle and the type of surface being monitored. If more than one type of surface is being monitored, the surface type and condition should be included with the meter reading from the point.

29. Conversion of Units

a. The alpha particle has such a short range that it is not considered to present any external hazard to the body. However, the source material can present a very serious hazard if it gains entry into the body. Measuring alpha particles from an alpha sources gives an indication of the amount of contamination on the ground. The amount of contamination is the important unit because this will determine the degree of decontamination required and will

give an indication of the potential airborne concentration of the alpha emitter. Thus, the unit finally concerned with is the weight of alpha emitter per unit area. In this case the unit is micrograms of plutonium-239 per square meter ($\mu g \text{ Pu}^{239}/m^2$). To convert from the radiacmeter reading to $\mu g \text{ Pu}^{239}/m^2$, the following formula is used:

$$\mu g \text{ Pu}^{239}/m^2 = \frac{R \times E \times 10^4}{1.4 \times 10^5 \times A} = \frac{R \times E}{14 \times A}, \quad (\text{Equation 1})$$

Where R , = radiacmeter reading ($mrad/hr$ or cpm),

E = efficiency factor to convert $mrad/hr$ or cpm to dpm (disintegrations per minute),

A = area of probe in cm^2 ,

10^4 = factor to convert cm^2 to m^2 , and

1.4×10^5 = specific activity of Pu^{239} ($dpm/\mu g$).

The values of E and A are given for each standard radiacmeter in table V.

Table V. Values of E and A for Standard Alpha Radiacmeters

Instrument	Efficiency factor	Probe area (cm^2)
IM-170/PD (AN/PDR-60) ----	2	59
IM-154/PD (AN/PDR-54) ----	2	61
IM-156/PD -----	5,680	91

b. Equation 1 is derived with the assumption that there will be no sample self-absorption or surface absorption of alpha particles. These assumptions make the equation good only for very smooth surfaces, such as glass, with the contamination evenly divided over the surface, which seldom occurs in field situations. Equation 1 can be modified for field use by combining the constant factors (E and A) in equation 1 and a surface factor into one overall correction factor. Then:

$$\mu g \text{ Pu}^{239}/m^2 = R(CF), \quad (\text{Equation 2})$$

where, R = meter reading (cpm or $mrad/hr$), and

CF = correction factor to convert meter readings into $\mu g \text{ Pu}^{239}/m^2$.

Correction factors for some common surfaces are given in table VI. If the surface being monitored is not listed in table VI, use the correction factor for the surface which most

nearly approximates the surface being monitored. Occasionally very rough surfaces will be encountered for which none of the correction factors in table VI is appropriate. For example, when monitoring on plowed ground with the IM-170/PD radiacmeter, the factor used is approximately $1/8$. A reading of 80,000 cpm obtained on plowed ground is equivalent to approximately 10,000 $\mu\text{g Pu}^{239}/\text{m}^2$. In cases where no appropriate correction factors can be determined, record the meter readings and consult with the RADCON Team leader upon his arrival.

Table VI. Correction Factors for Some Common Surfaces

Instrument	Correction factor from meter reading to $\mu\text{g Pu}^{239}/\text{m}^2$			
	Concrete	Soil	Plywood	Smooth*
IM-170 (AN/PDR-60) -----	1/200	1/170	1/240	1/400
IM-154 (AN/PDR-54)** -----	1/200	1/170	1/240	1/400
IM-156/PD -----	7	8	6	5

* Calculated from equation 1 and safesided.

** If either the X20 or X100 shield is used, multiply the answer obtained by 20 or 100 respectively.

c. Table VII gives the converted meter readings for all the standard alpha instruments. This table gives the monitor a quick reference for field use in converting meter readings to $\mu\text{g Pu}^{239}/\text{m}^2$. The readings given are for smooth surfaces only.

Table VII. Converted Readings for Smooth Surfaces

Meter reading		Contamination level
(cpm)	(mrad/hr)	($\mu\text{g Pu}^{239}/\text{m}^2$)
20,000	10	50
40,000	20	100
60,000	30	150
80,000	40	200
100,000	50	250
200,000	100	500
300,000	150	750
400,000	200	1,000
600,000	300	1,500
800,000	400	2,000
1,000,000	500	2,500
1,200,000	600	3,000
1,400,000	700	3,500
2,000,000	1,000	5,000
-----	5,000	25,000

30. Air Monitoring

a. Because alpha contamination presents a very serious hazard once it gains entry into the body, the amount of contamination present in the air must be measured. Inhalation is the principal means by which alpha emitters enter the body. The amount of alpha emitters deposited in the body depends largely on their concentration in the air which is inhaled, the particle size, and the length of time the individual is exposed. The maximum permissible airborne concentration for Pu^{239} has been established, for both restricted areas and unrestricted areas, by Title 10, Code of Federal Regulations, Part 20. These limits, given in microcuries per milliliter ($\mu\text{c}/\text{ml}$),¹ are as follows:

Restricted area:

$4 \times 10^{-11} \mu\text{c}/\text{ml}$ (40 hour/week exposure).

Unrestricted area:

$1 \times 10^{-12} \mu\text{c}/\text{ml}$ (continuous exposure).

To determine the concentrations present at or near the accident site, air samples must be collected and analyzed.

b. In a nuclear accident that results in large-scale air contamination, the particulate matter will probably have been deposited on the ground or dispersed before air sampling can be initiated. The problem in most cases is one of determining the hazard due to resuspension of the contaminants that are already on the ground.

c. Air monitoring includes the collecting of particles suspended in the air (sampling), measuring the radioactivity of the collected sample (analysis), and calculating the amount of radioactive material per unit volume of air.

31. Air Sampling

Air sampling must be performed to determine the airborne contamination at a specific location and time and/or to determine the contamination in an area over a period of time. The samples are divided into two principal types, based on the length of time involved in the collection.

¹ For air, at standard temperature and pressure, 1 milliliter (ml) is equivalent to 1 cubic centimeter (cc).

a. *Spot Sample.* A spot sample is usually taken for a period of less than 10 minutes and, when analyzed, indicates the airborne contamination at a precise location at a given time.

b. *Continuous Sample.* A continuous sample is taken over a measured period of time, usually 2 hours or more, and indicates the average conditions in the sampled area over the period of time during which the sample was taken. This type of air sample will represent the conditions under which individuals may have been exposed.

32. Air Sampling Equipment

a. There are a number of different methods obtaining a continuous air sample. The physical state of the contaminant will determine the collecting procedure used to evaluate the quantity of radioactive contamination. For a particulate contaminant, methods such as filtration, impaction, impingement, and electrostatic precipitation may be used. Trays that have been surfaced with an adhesive may be used as collectors to make a qualitative check of airborne particles or to detect resuspension and spread of the contamination. However, for a gaseous contaminant, different methods are available depending on the contaminant. Certain gaseous contaminants are either absorbed or adsorbed into a collecting material which is then evaluated. Other radioactive gases, particularly tritium, can be detected and counted by passing a sample through a flow-through ionization chamber, receiving an instantaneous indication.

b. Filtration is the most practical air sampling method at a nuclear accident site. Special situations may require the use of other methods enumerated. Devices that utilize filter papers are described below.

- (1) The Staplex high-volume air sampler is an example of a vacuum-type apparatus used to draw large volumes of air through a high efficiency filter paper. The efficiency of any sampler is ultimately determined by the type of filter paper used. Collection and detection of an alpha emitter requires a tight weave and fine grade filter paper such as Staplex Model TFA-66 or Whatman 41. The flow rate of the

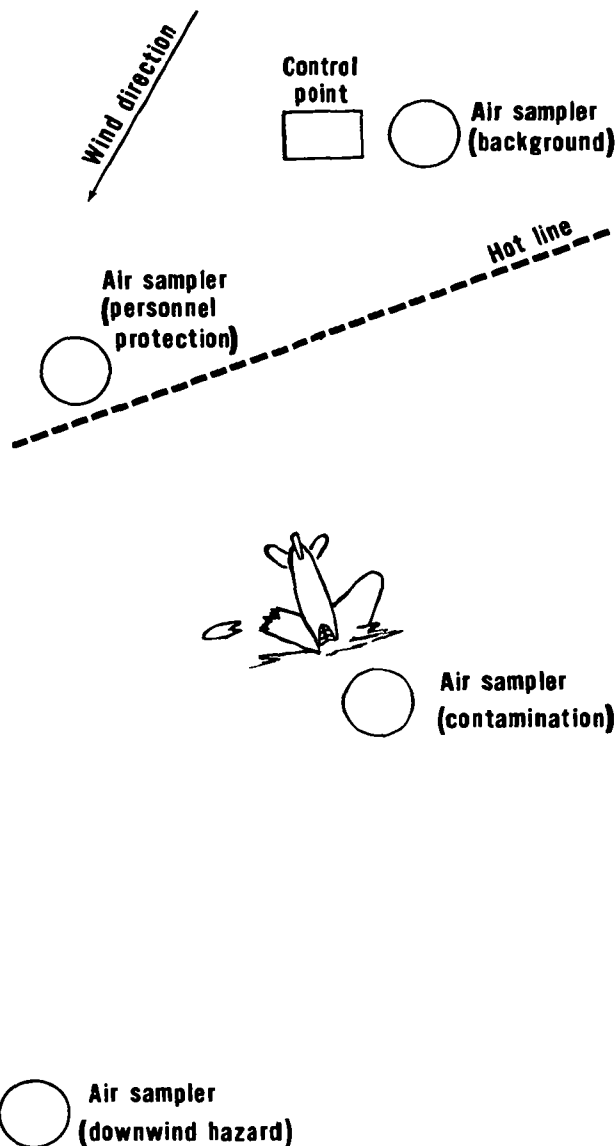


Figure 9. Air sampler employment.

sample will be determined by the apparatus and filter paper used. The Staplex High-Volume Air Sampler (fig. 3), Model TF1A-27, requires 110-volt, 60-cycle alternating current. Model TF1A-4 requires 24-volt direct current.

- (2) There are a variety of other electrically operated air samplers that may be used; even an ordinary home vacuum cleaner can be used if the flow rate is calibrated.

33. Air Sampling Procedures

a. *Location.* Samplers will be located so that the extent and amount of airborne contamination can be determined both downwind and at the accident site. Placement of the air samplers is vital if the data are to be valid. Figure 9 shows how air samplers might be employed at an accident site. An air sampler is placed at least 550 meters upwind from the accident site to obtain a background air sample. One 30-minute sample is adequate for determining the background radioactivity. Another air sampler should be placed at the hot line and operated continuously during the operation since there will be personnel present in this area without respiratory protection. A third air sampler is placed about 25 meters downwind from the accident site to determine the hazard in the immediate area and is operated continuously during all operations that require personnel in the accident area. A fourth air sampler is placed downwind from the accident site at a distance dependent on the wind velocity (table VIII). This air sampler should be operated until it can be safely assumed that there is no danger of airborne contamination at that point.

Table VIII. Air Sampler Placement

Wind velocity		Downwind distance (meters)
(mph)	(knots)	
6-10	4-9	1,050
11-15	10-13	1,550
16-20	14-17	2,050
Above 20	Above 17	2,550

b. *Rate.* Any sampling rate may be used as long as it is known along with the collecting efficiency of the sampling apparatus. The manufacturer's rated flow rate may be used; however, to assure accuracy, the sampler equipped with the type filter being used should be calibrated at the accident site. Samplers calibrated at sea level must be recalibrated at higher altitudes because of the lower air density.

c. *Period.* The length of sampling time will depend on the flow rate, amount of airborne dust that may cause filter clogging, and the volume required to detect maximum permissible concentrations. Samples of 100 to 1,000 cubic meters are necessary to obtain results within +10 percent of true concentrations.

d. *Recording Data.* The following data should always be recorded for air samples:

- (1) Location of sampler.
- (2) Average flow rate.
- (3) Total sampling time.
- (4) Type of sampler.
- (5) Size and type of filter paper.
- (6) Type of radioactive material, if known.
- (7) Wind and weather conditions.
- (8) Operations being performed in the area during the sampling period.
- (9) Any other pertinent data.

34. Analysis of Air Sampling Data

a. Evaluation of a radioactive aerosol is accomplished by measuring the radioactivity of the sample collected with either a portable radiac device or a laboratory counting system. For an accurate determination, laboratory counting is required. If a heavy layer of dust is collected on the filter, absorption of the alpha radiation by the dust may preclude accurate counting of the sample. A shorter sampling time will result in a reduced dust load on the filter paper and allow a direct count of the sample.

b. After the air sample has been counted, corrections must be made for self-absorption by the filter paper. The dust particles collected on the filter paper will penetrate a finite distance into the paper, and part of the activity is absorbed by the paper and not measured by the counter. This is particularly true for alpha emitters. The factor for self-absorption may be obtained by counting the paper, burning it, plating out the remaining radioactive ash on a metal disk, and recounting it. In some instances this factor may be obtainable from the manufacturer or from other sources. Using Whatman No. 41 filter paper, about 70 percent of the alpha emitter is actually counted. With millipore filters, electrostatic precipitators, and cascade impactors, the count is nearly 100 percent; i. e., little or no self-absorption occurs.

c. Another correction factor to be considered is that due to radioactive materials normally present in the atmosphere in a given area, commonly called background. The background count for air samples may range from $10^{-9}\mu\text{c/cc}$ to $10^{-11}\mu\text{c/cc}$. This background count is due primarily to the spontaneous decay of uranium and

thorium minerals in the earth's crust. The concentration in the air will vary greatly with location and time; therefore, no fixed correction factor can be used. There are three methods that may be used to correct for this background count.

- (1) *Multiple samples.* Simultaneous samples are taken outside and inside the contaminated area. The outside sample is used for background correction and indicates the extent to which decay products interfere with the determination of long half-life alpha emitters. For details see TM 3-260.
- (2) *Decay compensation.* The immediate decay products of radon (Rn^{222}) may be considered completely decayed 4 hours after completion of sampling. The critical thoron (Rn^{220}) decay product, thorium B (Pb^{212}) with a half-life of 10.6 hours, will not decay to negligible proportions before about 72 hours. However, the decay of thoron may be estimated by taking two counts, one 4 hours after sampling and another at least 24 hours after sampling. The activity due to long half-life alpha emitters may be computed from the two counts by use of the following equation:

$$C_{LL} = \frac{C_2 - C_1 e^{-\lambda \Delta t}}{1 - e^{-\lambda \Delta t}},$$

where,

C_{LL} = counts due to long-lived isotopes (*cpm*),

C_1 = counts resulting from first count (less background of counter) (*cpm*),

C_2 = counts resulting from second count (less background of counter) (*cpm*),

λ = decay factor (for thoron, $\lambda = 0.0655$),

Δt = time between counts, and

e = base of natural logarithms (2.7183).

If the measurements are made at exactly 4 and 24 hours, the equation becomes

$$C_{LL} = \frac{C_2 - 0.271 C_1}{0.729}$$

(3) *Shielded samples.* A rough indication as to the activity of long half-life alpha emitters may be obtained by counting the contamination on the filter paper and then placing the filter paper in a glassine envelope, which the alpha radiation will not penetrate, and taking a second count. The radon and thoron activity will be reduced to about 30 percent by the glassine envelope; thus,

- (a) If the second reading is about 30 percent of the first, the majority of activity is due to radon and thoron.
- (b) If the second reading is less than 30 percent of the first, long half-life alpha emitters may be present in significant concentration.
- (c) If the second reading is nearly zero, the majority of the activity is due to long half-life alpha emitters.

35. Calculation of Air Concentrations of Contamination

a. Calculations of air concentrations of alpha-contaminated aerosols are normally reported in $\mu\text{c/cc}$. To evaluate the activity the following data are necessary:

- (1) Total activity (*cpm*).
- (2) Background activity (*cpm*).
- (3) Total volume of air passed through the filter (m^3).
- (4) Fraction of filter area counted.
- (5) Efficiency of filter.
- (6) Fraction of activity not self-absorbed.
- (7) Counting efficiency of the instrument used.
- (8) Conversion factor for dpm/m^3 to $\mu\text{c/cc}$ as used in this equation is 2.2×10^{11} .

b. To convert the activity to $\mu\text{c/cc}$, apply the data from a above as follows:

$$\text{Activity } (\mu\text{c/cc}) = \frac{(1) - (2)}{(3) (4) (5) (6) (7) (8)}.$$

If the concentration of long-lived (C_{LL}) alpha emitters is determined by the method in paragraph 34b(2), the value of C_{LL} is used in place of (1) — (2) in the numerator above. For details, see TM 3-260.

c. This equation, unfortunately, imposes a delay in obtaining data on airborne concentrations of radioactive material. In the event of an emergency, it is necessary to determine the airborne contamination with as little delay as possible. Using a standard, high-volume air sampler (Staplex), the data can be evaluated for field use with the IM-170/PD radiacmeter for alpha contamination by the following equation:

$$CONC = \frac{cpm \times F}{cfm \times T},$$

where, *cpm* = instrument reading in counts per minute,

cfm = flow rate in cubic feet per minute,

T = sample time in minutes,

F = correction factor (table IX),

CONC = concentration either in disintegrations per minute per cubic meter (*dpm/m³*) or microcuries per cubic centimeter (*μc/cc*), depending on the correction factor (*F*) used.

The background radioactivity should be subtracted from calculated airborne contamination before applying the data to protection standards (table I).

Table IX. Correction Factors For Field Air Sampling*

Filter paper size	<i>F</i> for <i>dpm/m³</i>	<i>F</i> for <i>μc/cc</i>
8- by 10-inch -----	1,000	5 x 10 ⁻¹⁰
4-inch diameter -----	200	1 x 10 ⁻¹⁰
1-inch millipore -----	150	1 x 10 ⁻¹⁰

* The factors given in this table are for Whatman 41 filter paper, using the IM-170/PD radiacmeter. For conditions other than these, the equation in paragraph 35b must be used. This table will provide an answer of the correct order of magnitude only, not a precise value.

36. Water Sampling

Water sampling involves collecting a representative volume of water (100 to 1,000 cc) and sending it to a laboratory for measurement of the radioactivity of the collected sample and

calculation of the amount of radioactive material per unit volume of water. The primary precaution to observe in collecting and handling water samples is to prevent additional contamination of the samples.

a. *Equipment.* The only item required for water sampling is a container in which to collect and ship the sample. This container can be glass, plastic, or metal. See TB CML 79 for water sampling components of the M4A1 water testing kit.

b. *Collection Procedures.* If the sample is taken from surface water, it should be taken away from the edge of a pond or stream to avoid debris and to obtain a representative sample. If the sample is to be taken from a faucet, water should be allowed to run a short time before the sample is taken.

37. Analysis of Water Samples

There is no portable radiac instrument capable of detecting alpha contamination in water. This must be done by appropriate laboratory analysis. A reading above background on the IM-141/PD radiacmeter (AN/PDR-27J) indicates a concentration of an unidentified beta-gamma emitter in excess of 10⁻³ *μc/cc*. Since the maximum permissible concentration of an unidentified radionuclide in water is 10⁻⁷ *μc/cc*, the IM-141/PD radiacmeter cannot be used to determine concentrations in the range 10⁻⁷ to 10⁻³ *μc/cc* unless the water is evaporated from the sample before measurements are made. Since such evaporation in the field would be most difficult, water samples should also be checked for beta-gamma contamination by appropriate laboratory analysis. As a general procedure, water samples should be checked with the IM-141/PD radiacmeter.

38. Performance of Air and Water Sampling

Air sampling and water sampling are performed by the RADCON Team since the Alpha Team does not have the necessary equipment.

SECTION VIII

CONTAMINATION CONTROL

39. General

The purpose of contamination control is to preclude the spread of contamination. Rigidly established operating procedures must be followed to achieve contamination control. This is accomplished in three steps—

- a. Initial monitoring upon arrival to determine the extent of contamination in the area.
- b. Anticontamination procedures to preclude the spread of contamination.
- c. Hot line procedures to control contamination spread during operations.

40. Initial Monitoring

a. Initial monitoring is performed immediately upon arrival at the accident scene by the Alpha Team. Both the ground and personnel must be thoroughly monitored for alpha and beta-gamma radiation. Contaminated objects, personnel, and areas must be segregated before detailed operations are initiated, otherwise team equipment and members will become contaminated. Civilian personnel who may have become contaminated may present special problems. Military personnel cannot forcibly detain, monitor, or segregate civilians. Therefore, the hazards should be explained to them in order to elicit their cooperation. Care must be taken not to alarm the civilian population unnecessarily. Civilian authorities present at the accident scene usually constitute the most effective means of dealing with civilians. It is essential to determine as quickly as possible the area contaminated. A method by which this can be accomplished rapidly, by the monitors of the Alpha Team, is discussed in *b* below. This method should be modified to fit the accident site.

- b. An alpha and beta-gamma rough point

survey to determine the approximate size of the contaminated area can be conducted rapidly by two monitoring teams. The area around the accident site is monitored at four to eight points as shown in figure 10. As these points are approached, the beta-gamma readings are noted; the presence of alpha contamination can be determined by using the PG-1 probe to detect the weak gamma emitted by plutonium-239. When a reading of 10 *mrad/hr* beta-gamma or an indication of alpha is obtained, the point is marked. If significant contamination is detected, caution should be exercised in taking the downwind readings because of possible airborne contamination. The area inside the points marked is used as the probable contamination area until time permits a more detailed survey to be conducted (fig. 11).

c. Once an exclusion area has been established, actions should be taken to remove extraneous civilian and military personnel from the accident scene to a clean area. Before leaving the exclusion area, all personnel and equipment should be thoroughly monitored. Clean areas must be located upwind of the accident site. Sites within the clean areas must be selected for the location of the control point, hot line, and other control facilities. After the control procedures have been initiated, a complete survey of the area must be conducted to determine the exact size of the 1,000 $\mu\text{g Pu}^{239}/\text{m}^2$ alpha and/or 10 *mrad/hr* beta-gamma exclusion area. Detailed survey procedures are discussed in section IX.

41. Anticontamination Procedures

a. Since alpha contamination is a hazard only if it gains entry into the body, the maximum amount of protection must be taken to prevent body entry of the contamination. Alpha contamination can gain entry by inhalation, ab-

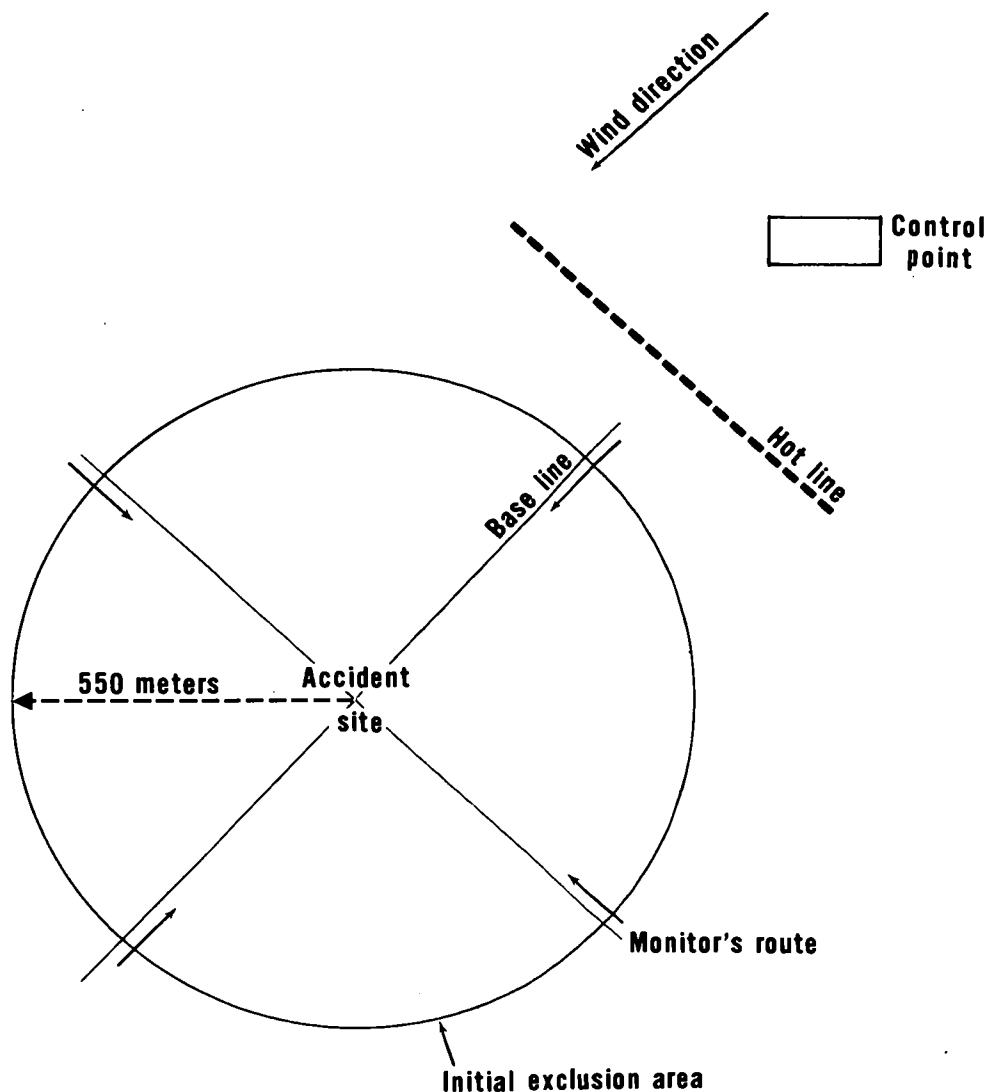


Figure 10. Rough point contamination overlay.

sorption through cuts and breaks in the skin, and ingestion. Maximum protection must be provided to prevent contamination of the individual and the air he breathes. Effective anti-contamination procedures are an important aspect of contamination control. Positive anti-contamination procedures will greatly reduce the personnel hazard and the subsequent decontamination efforts for equipment and personnel.

b. It is quite difficult to protect equipment against contamination because of size and usage. However, through proper selection, protection, and control, this problem can be reduced. If possible, equipment should never be

placed on the ground due to possible contamination. Always place some expendable material (such as heavy paper) beneath all items, including equipment in plastic bags. Only a minimum amount of equipment should be used. If possible, the same equipment should be used in the contaminated area rather than bringing in additional clean equipment for each operation. For example, transportation vehicles should be divided into two groups, with one group for exclusive use in the contaminated area. All selected equipment must be kept as clean as possible to reduce contamination and decontamination problems. All equipment used in the contaminated area should

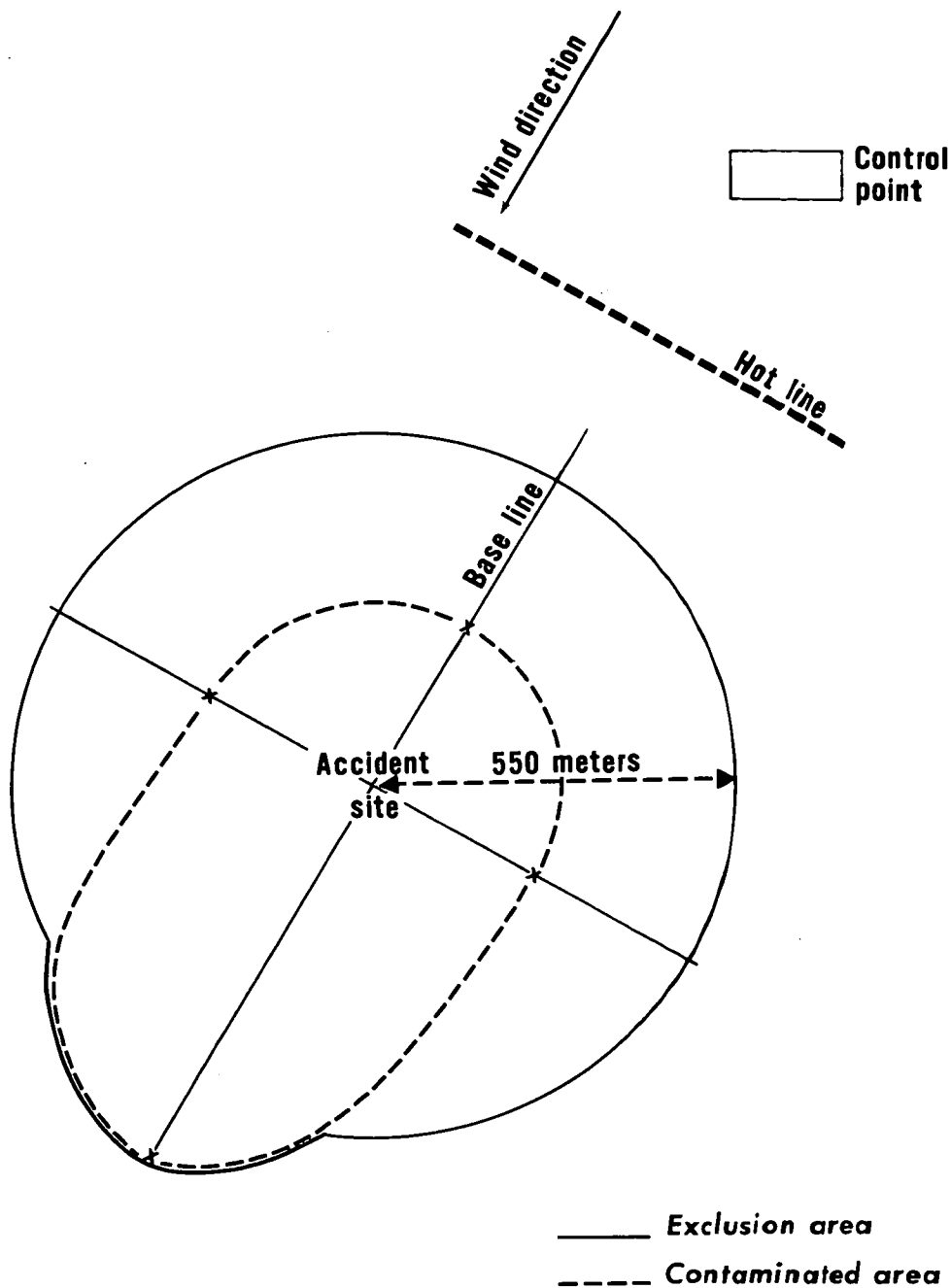


Figure 11. Exclusion area.

be decontaminated at the end of each operation as time permits and at the end of each day's operation. This equipment should remain on the hot side of the hot line until all cleanup is completed. This will reduce the number of contaminated vehicles and the possibility of spreading the contamination into the clean areas.

c. Certain equipment, such as radiacmeters, can be inclosed in plastic bags to reduce the possibility of contamination. However, alpha instrument probes must be left uncovered (fig. 12).

d. Personnel entering a contaminated area must be fully dressed in anticontamination

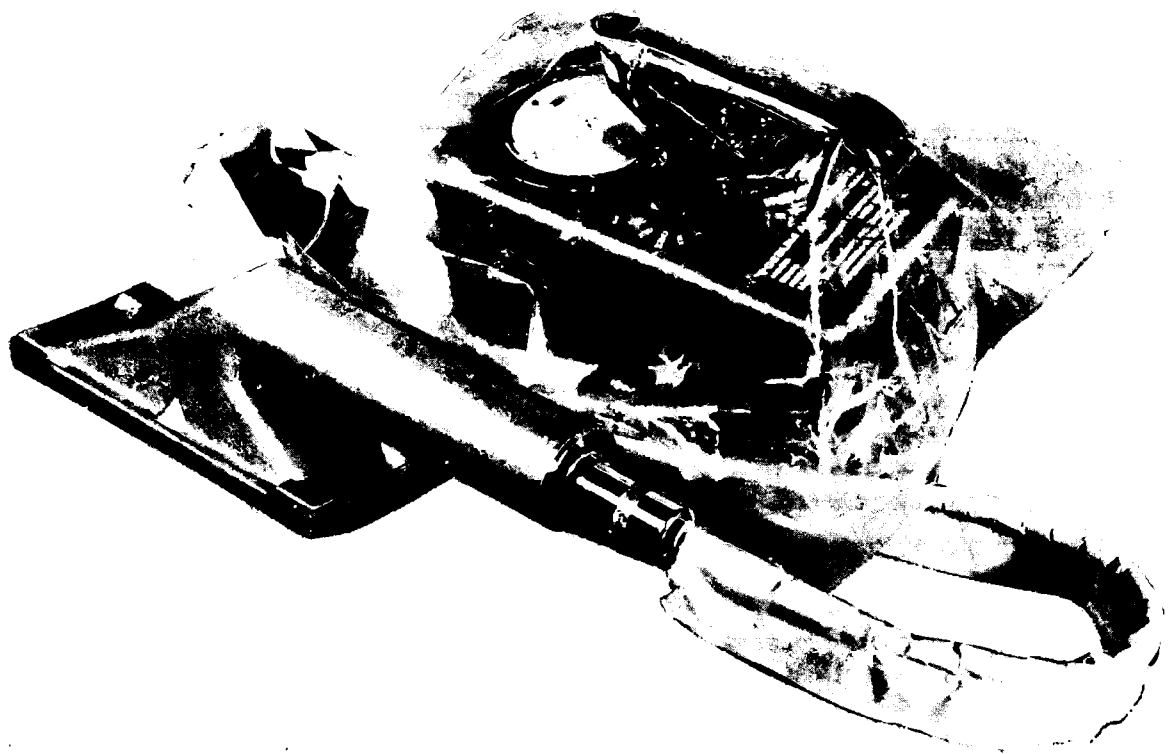


Figure 12. Alpha survey instrument inclosed in protective plastic.

clothing. This clothing will not reduce exposure to beta-gamma radiation but will reduce the body contamination, prevent the spread of contamination, and ease subsequent decontamination work. Anticontamination clothing (1, fig. 1) should consist of—

- (1) Coveralls, two sets. (One set may be of disposable material.)
- (2) Shoe covers.
- (3) Cotton gloves.
- (4) Hood or hair cap (i. e., surgeon's cap).
- (5) Respirator. (The type of respiratory protective device will be dictated by the extent and nature of the contamination. It may be an MSA respirator, a field protective mask, or a self-contained breathing apparatus. See table I.)

All openings must be taped closed (figs. 2, 3, and 4) so that there will be no entry of contamination to the body. This protective

clothing will be systematically removed during passage through the hot line to minimize the spread of contamination. The protective clothing is then packaged and processed as contaminated clothing.

e. In instances where protective clothing as outlined in *d* above is not available, fatigues may be worn. As in the case of anticontamination clothing, all openings must be taped closed. The use of fatigues presents an added problem in that clothing must be provided for personnel exiting the area as they will not be permitted to leave in contaminated fatigues.

42. Hot Line

a. The hot line is an arbitrarily established control line separating the contaminated area from the contamination-free area. The hot line is established during the initial entry and is situated upwind from the accident site. It

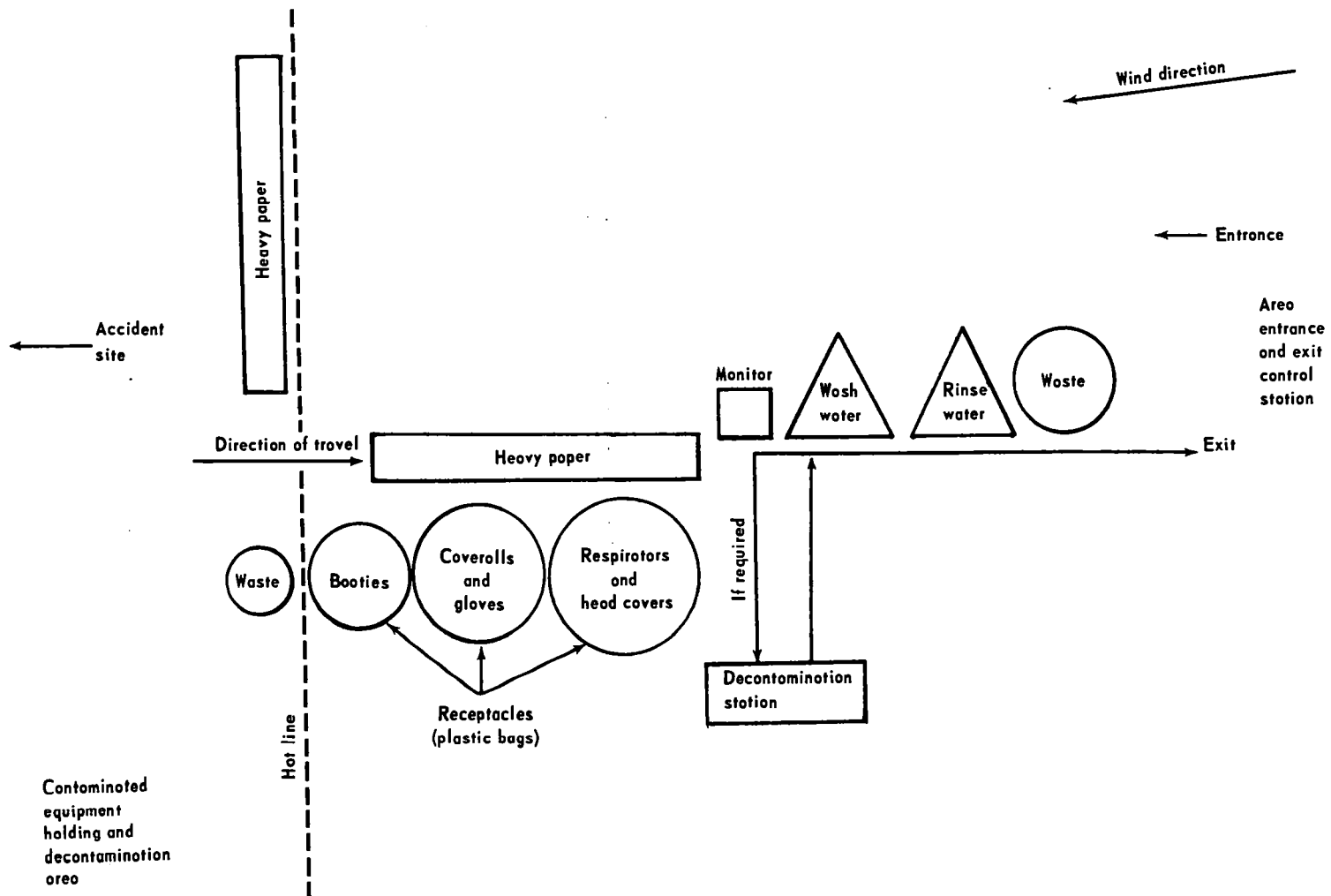


Figure 13. Hot line setup.

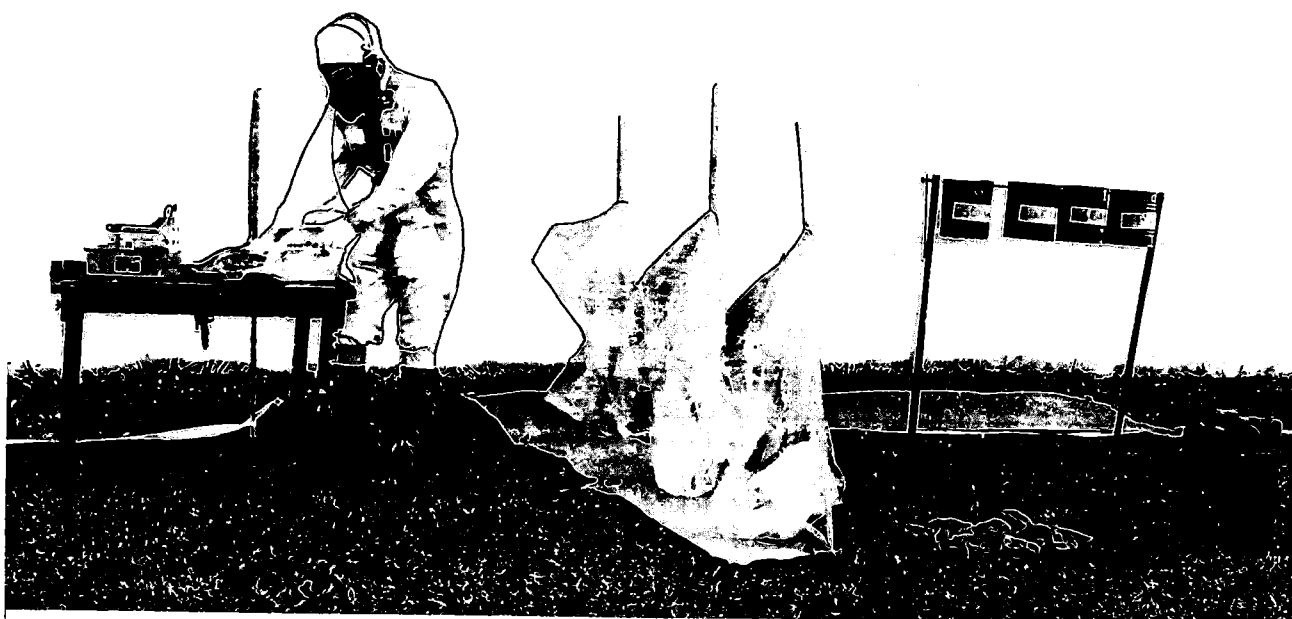


Figure 14. Hot line in operation.

must be continuously manned by at least one person, preferably two. All personnel working in the hot line area must be fully dressed in anticontamination clothing, with a respirator. All personnel and equipment entering and leaving the accident scene are channeled through the hot line. No one must be allowed to enter the clean area until he has been monitored and decontaminated. Further, no items or equipment must be allowed to pass into the clean area until they have been monitored and decontaminated or packaged.

b. The hot line equipment listed below can best be employed as illustrated in figures 13 and 14.

- (1) Anticontamination clothing stand.
- (2) Plastic bags.
- (3) Masking tape (2- and 3-inch widths).
- (4) Radiation signs and labels.
- (5) Communication equipment: AN/PRC-25 and/or field phone.
- (6) Decontamination supplies: water, detergent, alcohol, cotton, talcum powder, paper towels, surgical rubber gloves.

- (7) Radiation detection equipment: AN/PDR-60 and AN/PDR-27J.
- (8) Check source for alpha instruments.
- (9) Miscellaneous: spare personnel protective equipment, heavy paper, drinking cups and water, field table.

c. Recommended operational procedures for the hot line are outlined below.

- (1) Designation of a hot line by engineer tape, masking tape, or a line scratched on the ground. A space at least 10 feet wide is necessary.
- (2) Deployment of hot line equipment as illustrated in figure 13.
- (3) Use of an established sequence of actions by team members preparing to enter the accident area.
 - (a) Dress out in coveralls and shoe covers; tape openings.
 - (b) Adjust respirator for proper fit; remove respirator.
 - (c) Check radiacmeters and other equipment for proper operation.
 - (d) Put on gloves, and tape wrist openings.

- (e) Don respirator and hair cap or hood.
 - (f) Undergo inspection by hot line personnel for proper taping of clothing and functioning of equipment before crossing the control line.
- (4) Placement of all equipment and data on a large piece of paper adjacent to the hot line by personnel approaching from the accident area.
- (5) Use of an established sequence of actions by team members returning from the accident area.
- (a) Prepare to move single file through the hot line in an orderly manner.
 - (b) Upon reaching the hot line, remove all tape from outer clothing and deposit it in a waste receptacle (plastic bag) at the end of the hot line.
 - (c) Remove one shoe cover, have foot monitored by hot line personnel, step across the hot line with that foot, and place the shoe cover in the plastic bag. Remove the other shoe cover, have foot monitored, step completely across the hot line with that foot, and place the shoe cover in the plastic bag. (No one is allowed to cross the hot line while wearing contaminated shoe covers or shoes.)
 - (d) Remove the outer coveralls and gloves and place in the appropriate bags. Care must be taken to avoid contaminating the inner coveralls

with the gloves or contaminating the bare hands with the outer coveralls.

- (e) Undergo detailed monitoring of the entire body for both alpha and beta-gamma contamination. Especially check the neck, hands, and feet.
 - (f) Remove the respirator upon completion of monitoring. A nose swipe may be taken. Personnel found to be contaminated should be sent to a decontamination station, if one is available.
 - (g) As the final step in the sequence, thoroughly wash the face, neck, and hands; follow this as soon as possible with a complete body shower.
- (6) Periodic check of the hot line area for contamination during operations. Upon the conclusion of operations, the contaminated clothing bags are sealed, monitored, and labeled. The hot line area is checked for contamination before abandonment. Final release of the area will be authorized by the RAD-CON Team leader and the Medical Team leader.
- d. The hot line should be as complex as the situation demands. In large-scale operations over extended time periods, this may include quartermaster bath units and/ or chemical decontamination units. The hot line shown in figure 14 is a simple field setup using normal company equipment.

SECTION IX

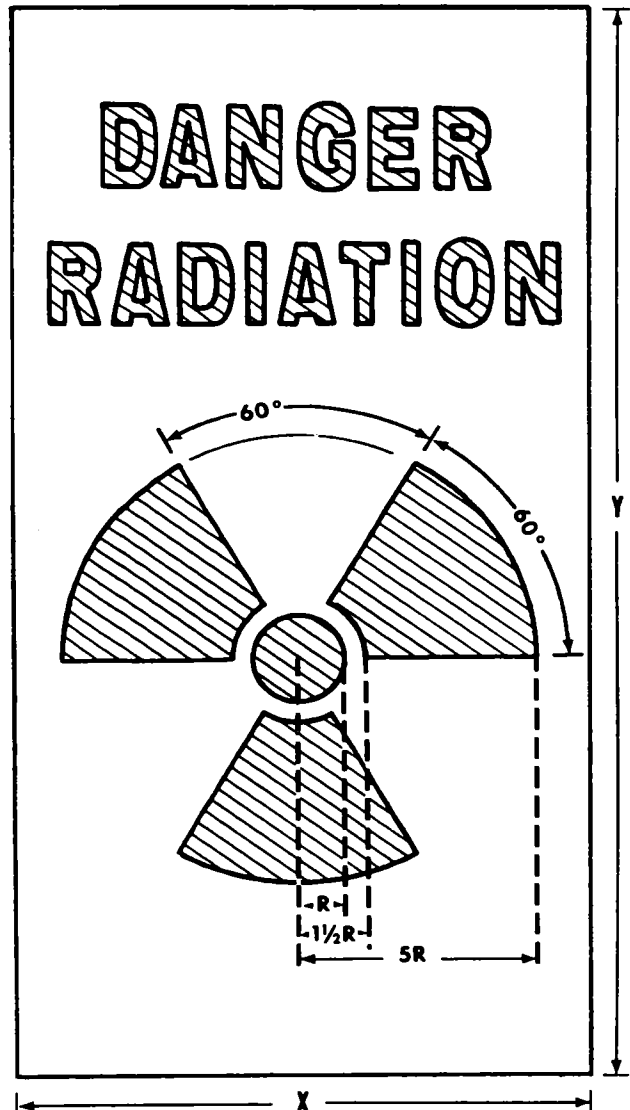
SURVEY TECHNIQUES

43. General

Upon notification of a nuclear accident, the Alpha Team will proceed to the accident site as quickly as possible. If an EOD Team arrives at the site first, its knowledge of the type of weapon involved and its preliminary radiological estimate of the situation will be available to the Alpha Team. In the absence of the AAR, the EOD Team leader will assume temporary command of the site. If the Alpha Team is the first to arrive, the team leader will assume temporary command of the site, establish the area to be controlled, and insure security of any classified weapon components (operating parts will be moved only by personnel of the EOD Team). Site control procedures are discussed in section XI. An immediate survey will be conducted to determine the presence of significant levels of hazardous contamination (para 44).

44. Alpha Team Survey

a. Upon arrival at an accident site, the Alpha Team leader should coordinate with military and civilian personnel at the scene of the accident. An area at least 550 meters (1,800 feet) in radius must be cleared of personnel and control of this exclusion area established. Personnel who have been in the exclusion area should be monitored for possible contamination. The team leader should establish his control point outside the exclusion area at least 550 meters upwind of the accident site. The exclusion area is the minimum safe explosive distance; however, two additional factors must be considered. First, fragments flying from a high-order detonation may extend farther than 550 meters. Second, preliminary investigation may reveal that radioactive contamination hazards extend beyond a 550-meter radius. The exclusion area must be increased to compensate for any hazard that extends outside the original



MINIMUM SIZE:

X must not be less than 8 inches.

Y must not be less than 10 inches.

R must not be less than 3/8 inch.

CROSS-HATCHED AREA: Magenta

BACKGROUND: Yellow

Figure 15. Radiological hazard marker
(front and back).

550-meter radius. The exclusion area should never be decreased until the area is released by the proper authority. The monitors will be provided with equipment necessary to monitor for beta-gamma and alpha radiation and to mark the contaminated area. Figure 15 shows an example of an approved type of radiological hazard marker which should be used in connection with nuclear accidents within CONUS. Radios, generators, and power-driven equipment will not be used in the accident area until the EOD team has determined the weapon condition because such equipment may emit sufficient energy to trigger a weapon involved in an accident.

b. After the exclusion area and the control point have been established, the Alpha Team should make a rough point survey of the exclusion area. This survey is designed to give the Alpha Team leader an immediate indication of the location and extent of the radiological contamination on the ground. The rough point survey should be initiated as soon as practical after arrival at the accident site.

- (1) A rough outline of the contaminated area is approximated by monitoring along four radial lines with the PG-1 probe. The radial lines can be established along the four primary directions or by any other means which can be quickly set up and utilized at the accident site. One suggested method is for the Alpha Team leader to shoot a base line from his control point through the accident site with a compass. The base line can be identified by stakes at either end outside the exclusion area. The second radial line is established at a 90° angle from the base line through the accident site (fig. 10). Monitors enter and monitor along the radial lines until they get an indication of contamination. They mark this point on the ground with engineer tape. Caution should be exercised when the monitoring teams approach the accident site from the downwind side.
- (2) If contamination is found, the Alpha Team leader will notify the AAR; and the team monitors will use the isodose

rate method (para 45b), shown in figure 17, to perform a detailed survey to delineate the contaminated area. The monitors will use the alpha probe for determining the 1,000 $\mu\text{g Pu}^{239}/\text{m}^2$ contamination line. If readings of 10 mrad/hr for beta-gamma or 1,000 $\mu\text{g Pu}^{239}/\text{m}^2$ are detected, the monitors will record the locations. The monitors will then proceed in a clockwise manner, using the isodose rate method, and mark the 10 mrad/hr line for beta-gamma or the 1,000 $\mu\text{g Pu}^{239}/\text{m}^2$ line for alpha with engineer tape. The contaminated area will be defined by the 1,000 $\mu\text{g Pu}^{239}/\text{m}^2$ perimeter unless the 10 mrad/hr beta-gamma contour line extends out farther from the accident site.

- (3) If alpha or significant beta-gamma contamination is encountered, a RADCON Team will be requested by the AAR; upon arrival of the RADCON Team, the Alpha Team may assist the RADCON Team as directed by the AAR. Personnel, animals, and equipment being moved from the area will be monitored and, when necessary, decontaminated. While the monitors are marking the area, the team leader may utilize available military or volunteer civilian personnel to operate a temporary decontamination station. After the contaminated area is marked, the team leader will report to the AAR for further instructions.

45. RADCON Team Survey

The RADCON Team will perform a detailed survey of the area around the accident site to include monitoring for hot spots of contamination outside the exclusion perimeter. Three methods for performing this survey are the "in-and-out" method, the isodose rate or isocon line method, and the grid method. The method most commonly used is the "in-and-out" method. The situation may require use of one of the other methods or an improvised method. There must be some means by which the monitors can locate themselves on the ground regardless of the method used. This can be ac-

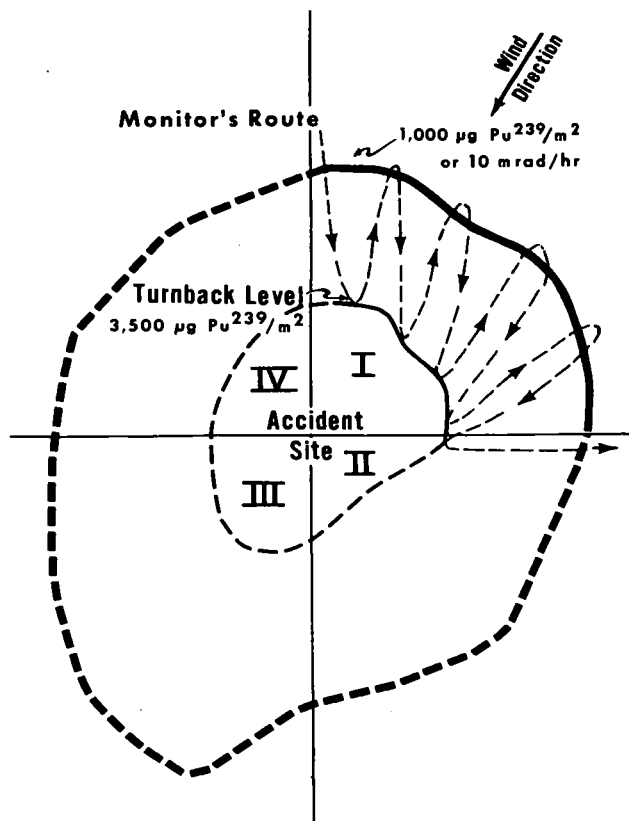
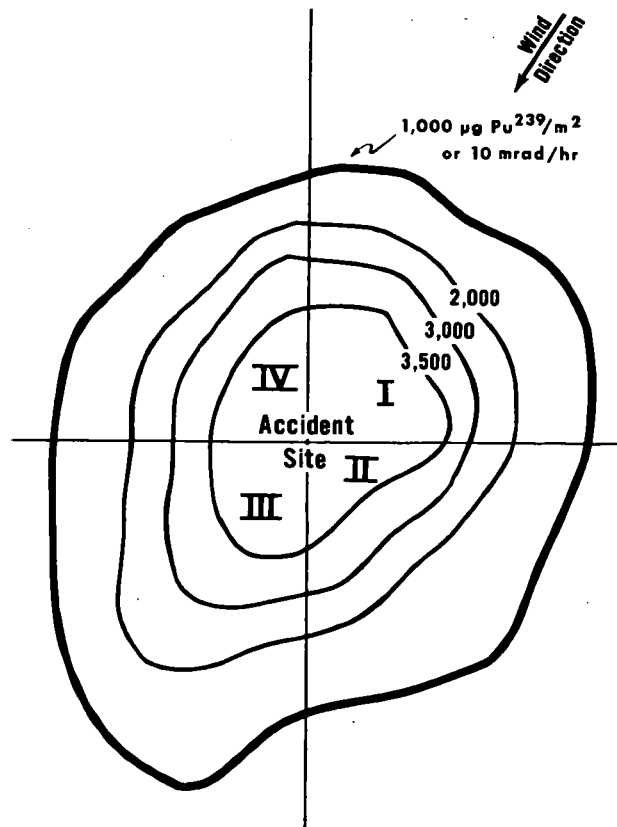


Figure 16. "In-and-out" method.

complished with a rough sketch using readily identifiable terrain features or by use of a compass. In actual practice, the system used will be designed for the specific situation encountered at the accident site. The control system used will be determined by the RADCON Team leader. Reporting procedures will be outlined prior to the start of the monitoring effort.

a. *"In-and-out" Method* (fig. 16). The area to be monitored will be divided into four sectors, and a monitoring team will be assigned to each sector. The monitors will proceed into the accident area and monitor until a turnback reading of $\mu\text{g Pu}^{239}/\text{m}^2$ alpha or of mrad/hr beta-gamma contamination is encountered. Suggested turnback readings are $3,500 \mu\text{g Pu}^{239}/\text{m}^2$ for alpha and 10 mrad/hr for beta-gamma contamination. The monitors will then proceed out of the area at a different angle until the $1,000 \mu\text{g Pu}^{239}/\text{m}^2$ level is encountered. The monitors must record and report the meter reading, the time, and location at which the readings are taken. If alpha contamination is



Note: Levels are preselected.

Figure 17. Isodose rate or isocon line method.

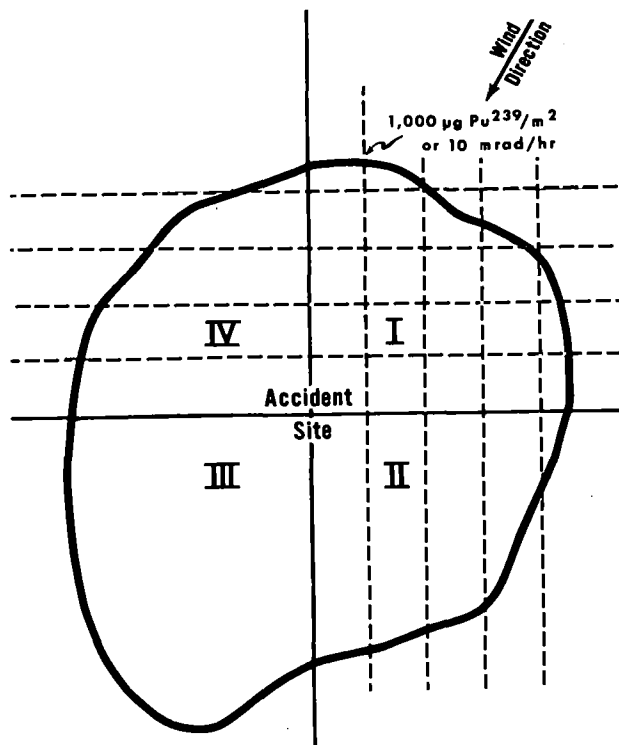
present, the type of surface will determine what meter reading, in cpm, is used by the monitoring team (see table VI for appropriate correction factors).

b. *Isodose Rate or Isocon Line Method* (fig. 17). The area will be divided into four sectors and teams will monitor for a given isodose rate or isocon line and define that line in their sectors. They may monitor for the 2,000, 3,000, and $3,500 \mu\text{g Pu}^{239}/\text{m}^2$ alpha and 10 mrad/hr beta-gamma lines if so directed. The monitors will report the time and location for all specified readings taken.

c. *Grid Method* (fig. 18). The area will be marked off in grids and divided into four sectors. The monitors will proceed to monitor the grid line intersections in their sector. The reading and time at each location will be recorded by the monitors.

46. Personnel Dosimetry

a. *General.* Procedures will be established so



Note: Distance between grid lines depends upon local factors.

Figure 18. Grid method.

that the total dose received by any individual during recovery operations will not exceed that specified by the AAR at the accident site. As a guide, 1.25 rem per calendar quarter from all sources of nuclear radiation is an acceptable dose. However, a larger dose may be permitted in order to save lives. No individual under 18 years of age will be deliberately exposed to ionizing radiation. For further details, see Title 10, Code of Federal Regulations, Part 20, and AR 40-14.

b. Film Badges. Film badges will be used as the basis for the official radiation dose records

for personnel involved in nuclear accident contamination control. If film badge development service is not provided with the site logistical support, the team leader of each emergency team will insure that the film badges are processed and that the results are recorded in accordance with AR 40-14. Film badge service may be obtained from Lexington Army Depot, Lexington, Ky, or Sacramento Army Depot, Sacramento, Calif.

c. Pocket Dosimeters. Pocket dosimeters will be used as exposure dose control devices at accident sites, and dosimeter readings will be used as a guide to determine personnel exposures.

d. Internal Exposure Controls. The Radiological Emergency Medical Team or the RADON Team should be consulted regarding nose swipes and urine sample collections which will be utilized for medical evaluation of exposed individuals.

- (1) Nose swipes will be taken as early as possible from all individuals associated with the area of a nuclear accident when there is no definite information to indicate the absence of contamination. Nose swipes will also be taken from individuals who are known to have worked in an area of contamination.
- (2) Urine samples will be collected from individuals whenever the contamination level on their nose swipes is above 200 dpm for both nostrils or when there is a suspicion of internal contamination by any mode of entry into the body. Care should be exercised not to contaminate the specimen or the container while obtaining the urine specimen.

SECTION X

DECONTAMINATION

47. General

Emergency teams normally will not undertake large-scale decontamination operations. However, they may be required to provide advice and supervision of decontamination operations. Decontamination methods will vary depending on the amount and type of contamination involved.

48. Considerations

There are several factors that should be considered when decontamination operations are required.

a. The hazards of radiation can be decreased by allowing the material to decay or by covering the contamination. The radiation hazard can be eliminated in a certain area by transporting the contamination to a new location. Generally, short half-life emitters are handled through radioactive decay, while the longer half-life emitters may be covered or removed.

b. The nature of the surface of the contaminated area or item will determine the decontamination method to be used.

c. Optimum effective decontamination will start with the simplest method. More complicated methods can then be attempted to reduce the remaining contamination.

d. Decontamination normally will be performed from the lowest level of contamination to the highest level.

e. Decontamination of personnel normally will receive priority.

49. Principles

The three general principles of radiological decontamination are removal, sealing, and aging. For best results, the use of a combina-

tion of methods derived from these principles may be necessary (TM 3-220).

a. Removal is effective for all types of contamination and is employed in the majority of cases where time is the limiting factor. Table X is a summary of removal methods for decontamination of various surfaces. Table XI provides guidance on the efficiency of certain removal methods.

(1) Advantages of removal are that it—

- (*a*) Provides, in certain cases, a relatively rapid means of decontamination.
- (*b*) Permits early restoration of equipment and material.

(2) Disadvantages are that it—

- (*a*) Requires a large number of individuals.
- (*b*) Requires considerable equipment and supplies.
- (*c*) Produces a radioactive waste disposal problem.

b. Sealing is very effective against alpha contamination and should be used when this is the only radiation hazard present.

(1) Advantages of sealing are that it—

- (*a*) Provides, in certain cases, a relatively rapid and inexpensive means of decontamination.
- (*b*) Permits reuse of contaminated equipment and supplies.

(2) Disadvantages are that it—

- (*a*) May require an extensive effort.
- (*b*) Does not provide a practical means for attenuation of gamma contamination because of the quantity of material required.
- (*c*) Requires periodic checks to insure that any sealing material used has not deteriorated.

c. Aging depends on the natural decay rate of the radioactive material and is very effective for short half-life emitters. It is the ideal method when time is unlimited.

(1) Advantages of aging are that it—

- (a) Does not require personnel.
- (b) Reduces all radioactivity to some degree.

(2) Disadvantages are that it—

- (a) Proves ineffective for contaminants with long half-lives because an extended period of time is required.
- (b) Imposes limited access security measures.
- (c) Precludes early usage of the contaminated area and equipment.

Table X. Removal Methods for Decontamination of Various Surfaces

Method	Surface	Action	Technique	Advantages	Disadvantages
VACUUM CLEANING.	Dry surfaces -----	Removes contaminated dust by suction.	Use conventional vacuum technique with efficient filter.	Good on dry porous surfaces. Avoids water reactions.	All dust must be filtered out of exhaust. Machine is contaminated.
WATER -----	All nonporous surfaces (metal, painted, plastic, etc.).	Dissolves and erodes.	Hose with high pressure water at an optimum distance of 15 to 20 feet. Spray vertical surfaces at an angle of incidence of 30° to 45°; work from top to bottom to avoid recontamination. Work from upwind to avoid spray. Determine cleaning rate experimentally, if possible; otherwise, use a rate of 4 square feet per minute.	All water equipment may be utilized. Allows operation to be carried out from a distance. Contamination may be reduced by 50%. Water equipment may be used for solutions of other decontaminating agents.	Drainage must be controlled. Not suitable for porous materials. Oiled surfaces cannot be decontaminated. Not applicable on dry contaminated surfaces (use vacuum); not applicable on porous surfaces such as wood, concrete, canvas. Spray will be contaminated.
STEAM -----	Nonporous surfaces (especially painted or oiled surfaces).	Dissolves and erodes.	Work from top to bottom and from upwind. Clean surface at a rate of 4 square feet per minute. The cleaning efficiency of steam will be greatly increased by using detergents.	Contamination may be reduced approximately 90% on painted surfaces.	Steam subject to same limitations as water. Spray hazard makes the wearing of waterproof outfits necessary.
DETERGENTS	Nonporous surfaces (metal, painted, glass, plastic, etc.).	Emulsifies contaminant and increases wetting power of water and cleaning efficiency of steam.	Rub surface 1 minute with a rag moistened with detergent solution then wipe with dry rag; use clean surface of the rag for each application. Use a power rotary brush with pressure feed for more efficient cleaning. Apply solution from a distance with a pressure proportioner. Do not allow solution to drip onto other surfaces. Mist application is all that is necessary.	Dissolves industrial film and other materials which hold contamination. Contamination may be reduced by 90%.	May require personnel contact with surface. May not be efficient on long-standing contamination.

COMPLEXING AGENTS: Oxalates Carbonates Citrates	Nonporous surfaces (especially unweathered surfaces; i.e., no rust or calcareous growth).	Forms soluble complexes with contaminated material.	Complexing agent solution should contain 3% (by weight) of agent. Spray surface with solution. Keep surface moist for 30 minutes by spraying with solution periodically. After 30 minutes, flush material off with water. Complexing agents may be used on vertical and overhead surfaces by adding chemical foam (sodium carbonate or aluminum sulfate).	Holds contamination in solution. Contamination may be reduced by 75% in 4 minutes on unweathered surfaces. Easily stored; carbonates and citrates are nontoxic, noncorrosive.	Requires application for 5 to 30 minutes. Little penetrating power; of small value on weathered surfaces.
ORGANIC SOLVENTS.	Nonporous surfaces (greasy or waxed surfaces, paint or plastic finishes, etc.).	Dissolves organic materials (oil, paint, etc.).	Immerse entire unit in solvent or apply by wiping procedure (see DETERGENTS).	Quick dissolving action. Recovery of solvent possible by distillation.	Requires good ventilation and fire precautions. Toxic to personnel. Material bulky.
INORGANIC ACIDS.	Metal surfaces (especially with porous deposits; i.e., rust or calcareous growth); circulatory pipe systems.	Dissolves porous deposits.	Use dip-bath procedure for movable items. Acid should be kept at a concentration of from 1 to 2 normal (9 to 18% hydrochloric, 3 to 6% sulfuric acid). Leave on weathered surfaces for 1 hour. Flush surface with water, scrub with a water-detergent solution, and rinse. Leave in pipe circulatory systems 2 to 4 hours; flush with plain water, a water-detergent solution, then again with plain water.	Corrosive action on metal and porous deposits. Corrosive action may be moderated by addition of corrosion inhibitors to solution.	Personnel hazard. Wear goggles, rubber boots, gloves, and aprons. Good ventilation required because of toxicity and explosive gases. Acid mixtures should not be heated. Possibility of excessive corrosion if used without inhibitors. Sulfuric acid not effective on calcareous deposits.
ACID MIXTURES: Hydrochloric Sulphuric Acetic Acid Citric Acid Acetates Citrates	Nonporous surfaces (especially with porous deposits); circulatory pipe systems.	Dissolves porous deposits.	Same as for inorganic acids. Mixture consists of 0.1 gal. hydrochloric acid, 0.2 lb sodium acetate, and 1 gal. water.	Contamination may be reduced by 90% in 1 hour (unweathered surfaces). More easily handled than inorganic acid solution.	Weathered surfaces may require prolonged treatment. Same safety precautions as required for inorganic acids.

Table X. Removal Methods for Decontamination of Various Surfaces—Continued.

Method	Surface	Action	Technique	Advantages	Disadvantages
CAUSTICS: Lye (sodium hydroxide) Calcium hydroxide Potassium hydroxide	Painted surfaces (horizontal).	Softens paint (harsh method).	Lye paint-remover solution: 10 gal. water, 4 lb lye, 6 lb boiler compound, 0.75 lb cornstarch. Allow lye paint-remover solution to remain on surface until paint is softened to the point where it may be washed off with water. Remove remaining paint with long-handled scrapers.	Minimum contact with contaminated surfaces. Easily stored.	Personnel hazard (will cause burns). Reaction slow; thus, it is not efficient on vertical or overhead surfaces. Should not be used on aluminum or magnesium.
Trisodium phosphate.	Painted surfaces (vertical, overhead).	Softens paint (mild method).	Apply hot 10% solution by rubbing and wiping procedure (see DETERGENTS).	Contamination may be reduced to tolerance in one or two applications.	Destructive effect on paint. Should not be used on aluminum or magnesium.
ABRASION ----	Nonporous surfaces.	Removes surface --	Use conventional procedures, such as sanding, filing, and chipping; keep surface damp to avoid dust hazard.	Contamination may be reduced to as low a level as desired.	Impracticable for porous surfaces because of penetration by moisture.
Sandblasting	Nonporous surfaces.	Removes surface --	Keep sand wet to lessen spread of contamination. Collect used abrasive or flush away with water.	Practical for large surface areas.	Contamination spread over area must be recovered. Contaminated dust is personnel hazard.
Vacuum blasting.	Porous and nonporous surfaces.	Removes surface; traps and controls contaminated waste.	Hold tool flush to surface to prevent escape of contamination.	Contaminated waste ready for dispersal. Safest abrasion method.	Contamination of equipment.

Table XI. Typical Decontamination Efficiencies

Material	Vacuum cleaning	High pressure water	High pressure water plus detergent	Sand-blasting	Steam cleaning
Glass ---	98	98	100	100	97
Painted wood --	99	98	99	100	91
Asphalt --	72	92	98	92	22
Concrete--	74	98	96	100	27
Unpainted wood --	36	85	99	99	85

50. Personnel Decontamination

a. *General.* If the accident site is contaminated, a personnel monitoring station should be established for personnel leaving the contaminated area. Military personnel will decontaminate themselves. Civilians who are contaminated will be advised to change clothing and place the contaminated clothing in a bag for decontamination. After removing contaminated clothing, they should take a shower and be remonitored. The presence of contaminated female personnel will require that separate decontamination facilities be provided.

b. *Alpha Monitoring.* Monitoring is performed to detect contamination on the body, serve as a guide for decontamination, and to prevent internal hazards. Monitoring of individuals for alpha contamination is very slow and difficult; emergency team personnel working in contaminated areas may make only a precursory monitoring of individuals if routine procedures require decontamination and change of clothing. In case of rain, alpha monitoring may be misleading, based on attenuation by the moisture present.

(1) *Equipment.* The selection and correct use of proper instruments is essential. Radiacmeters equipped with separate probes and earphones are used for monitoring of personnel.

(2) *Procedures.* A complete and careful check of those parts of the body and clothing most susceptible to contamination must be made. A systematic sequence should be followed; for example, monitoring the hands first, then monitoring the face and head,

and proceeding down the body to the feet ((d) below).

- (a) The use of earphones results in an easier and more accurate monitoring effort. The monitors can watch the probe so that it will not become contaminated and can hear an audible response if contamination is present.
- (b) The probe should be held close to the surface being monitored and moved with a slow, steady motion. The distance from the surface should be 2 to 3 centimeters for beta-gamma contamination. The probe should be placed directly on the surface for alpha contamination.
- (c) Personnel being monitored should stand on a pad or platform located on the contaminated side of an arbitrary line drawn in the area. The person should be instructed to stand with feet spread apart about 30 centimeters (approximately 1 foot) and arms extended sideward with palms up and fingers straight.
- (d) Steps to be followed are listed below:
 1. Monitor both hands and forearms with palms up; repeat with hands and arms turned over.
 2. Monitor the entire front of the body, starting at the top of the head. Check the forehead, nose, mouth, neckline, torso, knees, and ankles thoroughly. Have the person turn around; repeat the procedures from head to ankles.
 3. Have the person raise one foot; monitor the sole. Repeat the procedure for the other foot.
- (e) Wounded personnel should be monitored under the supervision of, or by, medical personnel. Contamination should be a secondary consideration if the wounds require immediate medical attention.
- (f) If contamination is found in excess of prescribed permissible limits as indicated in table XII, decontamination will be required. If no con-

tamination is found, no further action is required except that if the water supply is not critical, personnel should be required to wash or shower.

c. Decontamination in the Field.

- (1) Establishment of a temporary personnel decontamination station may be necessary. If so, it should be located where entry into and exit from the contaminated area takes place. This station should include—
 - (a) Containers for waste materials.
 - (b) Containers for contaminated clothing.
 - (c) Swabs and masking tape for removing hot spots.
 - (d) Containers of soapy water.
 - (e) Containers of rinse water.
 - (f) Towels and supply of clothing.
 - (g) Radiac instruments.
- (2) Persons coming from the contaminated area will be initially monitored. They will then remove outer clothing consisting of boot covers, gloves, respirator, coveralls, and surgeon's caps. Any hot spots will be cleaned with swabs or masking tape to reduce spread of contamination.
- (3) After washing with soapy water and rinsing, individuals must be thoroughly dry before being remonitored since water will shield alpha particles.

d. Detailed Procedures. If decontamination is not fully effective, the following techniques will be used for each specific area:

- (1) *Body and skin.*
 - (a) Spot clean hot spots, using swabs and masking tape. Remonitor to determine effectiveness.
 - (b) Wash the entire body, hair, and hands, using soap lather and plenty of hot water. Clean fingernails.
 - (c) If soap lather is not effective, use the following materials which can normally be procured from local sources or the nearest medical facility.

1. A water paste mixture of 50 percent powdered detergent and 50 percent cornmeal. Massage with this mixture for 5 minutes and rinse thoroughly with water.

2. A 5-percent water solution of a mixture of 30 percent detergent, 65 percent Calgon or other water softener, and 5 percent Carbose (carboxymethyl cellulose). Apply, rub vigorously for 1 minute, and then rinse thoroughly with water.

3. A preparation consisting of 8 percent Carbose, 3 percent detergent, 1 percent Versene, and 88 percent water homogenized into a cream. Apply as a skin cleanser, without water, and then wipe off.

4. Waterless cleanser used by automobile mechanics.

- (2) *Hands.* Use soap lather and rinse. Clean fingernails. If contamination still remains after two attempts, apply mixtures listed in (1)(c) above as required. In some cases, wearing surgeon's rubber gloves for a period of approximately 30 minutes will cause sufficient sweating to remove contamination.

- (3) *Hair.*

- (a) Wash hair several times. Repeat until decontamination has been effected or until further washings will obviously be ineffective.

- (b) If contamination is not lowered to acceptable levels, shave the head and apply skin decontamination methods to the scalp.

- (4) *Wounds.* Wounds will be treated by such first-aid measures as appropriate without consideration of contamination. If alpha contamination is found on other parts of the body when monitored, assume that wounds are alpha contaminated; after first aid, refer the casualty to medical personnel to determine the appropriate priority of action.

e. Evaluation. Upon completion of decontamination procedures, personnel should be

monitored again to insure that permissible levels shown in table XII are not exceeded (para 54). If permissible levels are still exceeded, medical assistance should be requested. Any surface being monitored for the presence of alpha contamination must be completely dry because water will shield residual contamination.

51. Clothing and Launderable Equipment Decontamination

a. Launderable equipment items can be placed in an automatic washing machine and laundered without damage to the equipment or the washing machine. Contaminated wash water should be collected for disposal in accordance with Title 10, Code of Federal Regulations, Part 20.

b. Those items that are contaminated above acceptable levels and that do not show any appreciable contamination reduction after three successive launderings should be disposed of as radioactive waste. Exceptions may be made if decay is likely to reduce the contaminants to the acceptable levels shown in table XII within a reasonable time and if security and storage requirements are economically feasible.

c. Automatic washing machines should be clean and free of soap scum to prevent deposition of contamination. If decontaminating agents (TM 3-220 and *d* below) are used, they will aid in keeping washers free of contamination.

d. Laundering involves seven operations of 5 minutes each, using hot water (120° to 140° F.) and additives as indicated below:

- (1) First wash—detergent.
- (2) Second and third washes—citric acid.
- (3) Fourth and fifth washes—chelating agent, such as Versene.
- (4) Sixth and seventh washes—water rinses.

e. After the decontaminated items have been laundered and completely dried, they must be checked for any remaining contamination.

f. Laundering of contaminated clothing should be accomplished only at an approved decontamination facility.

52. Equipment Decontamination

a. If the removal method of decontamination

is attempted on items that are contaminated to high beta-gamma levels, excessive personnel exposures may result. Natural decay may reduce the contamination to reasonable working levels.

b. The sealing method will not be normally used except for alpha contamination; it should be used only after removal methods have not been adequate.

c. Five general methods by which surface contamination may be removed or reduced are as follows:

- (1) Brushing or vacuum cleaning.
- (2) Washing, soaking, or scrubbing with hot or cold water. Soap, detergents, or chelating agents may be used.
- (3) Steam cleaning.
- (4) Cleaning with solvents.
- (5) Removing surface by using chemicals, abrasives, sandblasting, grinding, or electrolysis. (Care must be exercised to preclude inhalation of contaminated residue.)

For details on employing these methods, see TM 3-220.

d. The simplest removal methods will be tried first and then followed by the more difficult methods. Each method will be tried at least twice before a different method is used.

e. After an item has been monitored, an appropriate decontamination method will be selected and the necessary steps performed; then the results will be evaluated by remonitoring. This procedure will be repeated until the contamination is within permissible levels. The following details for specific items are furnished:

(1) Vehicles.

(a) If vehicles are required within a contaminated area, consideration should be given to using the same vehicles and keeping them in the contaminated area until completion of recovery operations. This will reduce the decontamination workload and the replacement costs.

(b) The highest levels of contamination usually will be under fenders, on the

undercarriage where lubricants are exposed, on wheels and tires, and inside where tracked into a vehicle. When liquids are used for decontaminating, procedures should be started at the top.

- (c) Weather-cracked tires are difficult to decontaminate. Disposal of contaminated tires may be necessary.

(2) *Radiacmeters.*

- (a) A low level of contamination can be allowed when instruments are being used in monitoring for high levels of contamination. The initial reading is noted and subtracted from any subsequent readings.
- (b) Contamination of the instrument may be determined by removing it from the contaminated area and checking the reading. Any reading above normal background indicates contamination of the instrument. Alpha instrument contamination can be determined within an alpha contaminated area by holding the sensitive detecting probe 30 centimeters (approximately 1 foot) or more away from all surfaces and noting the meter reading. The meter needle should indicate background, and only background clicks should be heard with the headset if the instrument is not contaminated.
- (c) Extreme care is necessary to avoid damaging the shields or probes when decontaminating alpha instruments. Most radiacmeters can be decontaminated by wiping the exterior surfaces with a damp cloth or sponge. Contamination can also be removed by running water under low pressure over the surface. Care must be taken to prevent water from entering the probe where it can short out the electronic circuits. With gas flow devices, operating the gas flow valve in the FLUSH position will help to keep the water being used out of the probe. A less effective means of decontamination is to wipe the probe gently with

clean cotton or a camel's hair brush. The adhesive surface of masking tape provides an effective means of decontaminating the instrument probe. If the probe cannot be decontaminated using these methods, the probe face should be changed.

(3) *Miscellaneous items.*

- (a) Moistureproof protective clothing, rubber boots, and similar items can usually be effectively decontaminated by showering, washing, or hosing prior to removal.
- (b) Canvas, rope, and similar coarse materials readily absorb contaminants which have a tendency to imbed deeper into the materials when liquids are used. Dry brushing or vacuum cleaning is the most suitable technique for such materials. If these procedures prove ineffective, the items may be allowed to age or may be disposed of if alpha or other long-lived emitters are involved.

f. When items are soaked, washed, or scrubbed with liquids other than water or with liquids containing soap, detergents, or solvents, clear water will be used as a final rinse.

53. Terrain Decontamination

a. *Definitions.* The following definitions are to be applied to terrain decontamination.

- (1) *Acute hazard area.* The cloud from a nuclear weapon high-explosive detonation contains radioactive dust and debris which falls out as the cloud passes. The area over which this cloud passes is the acute hazard area.
- (2) *Chronic hazard area.* The land surface area upon which residual contamination greater than $3,500 \mu\text{g Pu}^{239}/\text{m}^2$ remains after the passage of the radioactive cloud following a high-explosive detonation is a chronic hazard area. This contamination continues to present a chronic hazard to personnel in varying degrees until decontamination can be accomplished.
- (3) *Hot Spot.* An area which is contaminated to a degree significantly greater

than the surrounding area is a hot spot. A hot spot will surround the point of detonation. Other hot spots may be found in isolated or widely separated locations within and possibly outside the area of contamination. The location of hot spots cannot be accurately predicted.

b. *Alpha Contamination.* If the alpha contamination level is greater than $1,000 \mu\text{g Pu}^{239}/\text{m}^2$, decontamination should be accomplished. The method chosen will depend on the following factors:

- (1) Radiation level.
- (2) Size of area.
- (3) Type of surface.
- (4) Location.
- (5) Cost.

In addition, prime consideration must be given to the possibility of alpha contamination resuspension.

c. *Priorities.* When dealing with alpha contamination, the chronic hazard areas will require considerable attention and perhaps prolonged decontamination action. The chronic or long-term hazard is due to resuspension of alpha contamination from the ground. Alpha contamination is not a significant hazard as long as it does not become airborne. The important factors are the degree of contamination and the extent to which the material is bound to the surface. For example, a $1,000 \mu\text{g Pu}^{239}/\text{m}^2$ deposit of loosely bound material is more of a hazard than a like level of fixed material. Therefore, the degree of contamination should be reduced as much as possible by decontamination consistent with reasonable efforts and cost in the following priority:

- (1) *First priority* for decontamination should be assigned to chronic hazard areas and areas in which heavy contamination can readily become airborne. If these areas are solely within a nonessential or an unpopulated area, decontamination may be deferred in the interest of rendering assistance or carrying out damage control actions in populated areas or in those areas considered essential to the mission. How-

ever, if decontamination is to be deferred in the chronic hazard area, action must be taken to fix the contamination within the chronic hazard contour line to prevent its airborne movement.

- (2) *Second priority* for decontamination should be assigned to areas of contamination with less than $3,500 \mu\text{g Pu}^{239}/\text{m}^2$ but more than $1,000 \mu\text{g Pu}^{239}/\text{m}^2$. A serious health hazard will not result if there is a lapse of a day or two before starting decontamination of this area. However, if this area encompasses a heavily populated area, expeditious action may be warranted in the public interest.

- (3) *Third priority* for decontamination should be assigned to areas where the contamination is less than $1,000 \mu\text{g Pu}^{239}/\text{m}^2$. Decontamination is not mandatory in all cases; a decision to decontaminate such areas will be based upon an evaluation of the individual situation and should consider cost, morale factors, and potential liability claims against the Government. Hospitals, food facilities, nurseries, and similar places should be decontaminated to essentially zero levels whenever possible. In general, populated areas should be decontaminated to essentially zero levels whenever possible. Assistance from Civil Defense teams or other civilian organizations may be necessary to accomplish large-area decontamination in populated areas.

d. *Immediate Temporary Action.* Immediately upon determination and plotting of the contamination contours, it is best to fix temporarily all contamination levels above $1,000 \mu\text{g Pu}^{239}/\text{m}^2$. Spraying with water or with oil as a temporary "fixing" agent is sufficient to minimize the airborne resuspension hazards. Spraying operations should be controlled closely to prevent an accumulation of runoff water. A fine, misty airborne spray will best remove airborne particles as well as "fix" the soil surface or pavement contamination. Fire-trucks are capable of providing such a spray.

e. Methods. Methods employed for terrain decontamination will be based on either fixing or removing the contaminant. TM 3-220 and TM 5-225 give details of area decontamination.

(1) *Fixing.* Fixing is an excellent method that will inexpensively eliminate the hazard presented by the contaminant. Certain factors must be considered when employing fixing as a decontamination method. Fixing is unsuitable when there is a possibility that the contaminant may be uncovered and resuspended. Area exclusion must be maintained, and periodic monitoring must be performed to assure that the contamination remains fixed. Several fixing methods are described below.

(a) *Paving with asphalt or concrete.* Paving provides a permanent sealing of the contaminant (100 percent efficient) but is quite expensive when large areas are involved.

(b) *Plowing.* Plowing to a depth of about 30 centimeters (12 inches) will adequately mix and bury the contaminant (98 percent efficient).

(c) *Oiling.* Spreading a rapid cure oil over the area will form a semi-hardened surface within 24 hours (89 percent efficient).

(d) *Flooding with 1 inch of water.* Flooding accelerates natural weathering action and leaches the contaminant into the surface (85 percent efficient).

(2) *Removal.* Terrain decontamination by removal consists of removing the top 5 centimeters (2 inches) of the soil and hauling it away for burial. The soil should be semifixed with water or oil prior to this operation to prevent airborne resuspension. This method is quite expensive as considerable equipment and manpower are involved, and care must be taken to prevent accidental contamination spread during transportation of the removed contaminant.

f. Other Contamination. When dealing with other types of radioactive contamination, the contamination must be evaluated according to the hazard presented and decontamination accomplished to reduce this hazard to a safe level. The determination of a safe level is dependent on the particular contaminant. Other than alpha emitters, the only predictable contamination likely to be encountered is fission fragments. These are best handled through aging.

g. Evaluation. A complete remonitoring and evaluation of the accident area must be undertaken at 1-month, 6-month, and yearly post-accident intervals. In addition to the radiac instrument measurements, soil, water, and air samples must be collected and evaluated.

54. Permissible Levels of Contamination

a. Any radiological contamination should be reduced to the lowest level possible by decontamination procedures. These methods will usually result in a reduction and not in complete removal of residual contamination.

b. Permissible levels of contamination for various surfaces are given in table XII.

Table XII. Permissible Contamination Levels

Item ¹	Beta-gamma (mrad/hr at 2.5 cm)	Alpha ² (dpm/cm ²)
Clothing, including shoes:		
<i>Personal.</i> Should be replaced, decontaminated, or stored for decay if above -----	0.2	2
Protective:		
<i>General.</i> Should be replaced and/or decontaminated if above -----	2.0	8
<i>Laundry.</i> Should not be re- leased to public laundry if above -----	0.4	2
<i>Respirators.</i> Should be de- contaminated after use if above -----	1.0	2
Containers. Should be decontam- inated prior to nonradioactive use if above -----	0.3	2

¹ Fixed: no detectable activity on swipe test.

² Multiply by effective area of probe face.

Table XII. Permissible Contamination Levels—Continued

Item ¹	Beta-gamma (mrad/hr at 2.5 cm)	Alpha ² (dpm/cm ²)
Laboratories and work areas (nonradiation areas):		
Should be posted or decontaminated if above -----	0.25	5
Contamination should be fixed and checked periodically when decontamination is not possible if above -----	2.0	8
Skin: ³		
Body. Should continue decontamination if above -----	0.06	2

Item ¹	Beta-gamma (mrad/hr at 2.5 cm)	Alpha ² (dpm/cm ²)
Hands. Should continue decontamination if above -----	0.3	3
Vehicles: ⁴		
If used in radiation area, should not be above -----	2.0	8
If used in nonradiation area should not be above -----	0.4	4

¹ Fixed: no detectable activity on swipe test.

² Multiply by effective area of probe face.

³ All contaminated wounds will be treated by medical personnel.

⁴ No detectable activity if vehicles are for public use.

SECTION XI

CONTROL OF A NUCLEAR ACCIDENT SITE

55. General

a. Immediate military control of a nuclear accident site will be established by the nearest military commander (para 4b) pending arrival of the Army Area Representative or the representative of the service or agency having physical possession of the weapon. Control requirements will vary according to the magnitude of effects from the nuclear accident. Commanders of troop units should comply with the procedures stipulated herein to the extent commensurate with their capabilities prior to arrival of trained specialists. Some emergency actions may be performed by civilian personnel pending arrival of emergency forces from military installations. These actions may include—

- (1) Rescue, first aid, and evacuation of injured personnel.
- (2) Firefighting to prevent further personnel injury.
- (3) Notification of the nearest military installation and appropriate civilian agencies.
- (4) Control of movement of civilians and assistance in traffic control by the civil law enforcement authorities.

b. Upon arrival at the accident scene by any emergency team, the first consideration is *saving lives*. If it is necessary to evacuate injured personnel before decontamination can be accomplished, some type of notification must be given to local hospitals to warn them of possible contamination. Notification might be accomplished by use of a medical tag such as shown in figure 19.

c. Fires in which high explosives are involved should not be fought except to save lives (TM 5-315).

d. The emergency teams discussed in this manual do not have sufficient personnel as-

NOTICE TO MEDICAL AUTHORITIES

- 1 - RADIOACTIVE MATERIAL MAY BE PRESENT IN CONTAMINATION.
 - 2 - USE ALL POSSIBLE CARE TO PREVENT SPREAD OF CONTAMINATION.
 - 3 - CLEAN WOUNDS VERY THOROUGHLY, DEBRIDEMENT MAY BE ADVISABLE.
 - 4 - MEDICALLY, PATIENT SHOULD BE HANDLED LIKE ANY OTHER CASE.
-

Figure 19. Sample medical tag.

signed to provide control of the accident site and still accomplish their primary missions. The AAR will request additional support personnel from the nearest military installation to augment the emergency teams and to provide security and control of the area.

56. Control Measures

Upon arrival at the scene of the accident, the AAR or the commander of the nearest military installation or his representative will establish a control point to coordinate all activities directed toward control of the area. Measures required for control of the hazardous area include those for control of personnel and for control of contamination.

a. *Area Control.* The size and shape of any area requiring control measures will depend upon the nature of the accident and upon meteorological and terrain conditions. Since the contamination may extend for considerable distances, the area that must be evacuated will be determined by the AAR after evaluating monitoring and survey reports. Pending detection of alpha contamination or measurement of significant beta-gamma contamination, the following guides will be used to mark the exclusion area:

- (1) Coordinate with ordnance personnel to ascertain the area of hazard from blast effects of a nonnuclear detonation. This area can be used for initial contamination control prior to actual monitoring. However, in the event that EOD personnel have not arrived at the site, the exclusion area for detonation of high explosives will not be less than 550 meters in radius.
- (2) Extend the exclusion area downwind to distances dependent on varying ambient surface wind velocities. The minimum recommended distances are as shown in table VIII.

b. *Personnel Control.* Personnel in support of the control and recovery activities will be distinctively identified to facilitate control and to expedite recovery operations.

- (1) *Control point.* A control point will be established near but upwind and outside the exclusion area to minimize exposure to personnel.
- (2) *Control stations.* Entry and exit points to the exclusion area will be limited to the number absolutely necessary for control and recovery of the area. Those persons not associated with emergency operations should remain outside the exclusion area. Military police, if available, should be utilized to enforce personnel control measures prescribed by the AAR or the military commander in charge. If an accident occurs on other than military installations, employment of military police must be in conjunction with civilian law enforcement agencies (AR 360-5). Records of entry and exit times will be maintained.

EMERGENCY

THIS AREA PROBABLY CONTAINS RADIOACTIVE CONTAMINATION

Follow my directions to the radiation control point where you will be given further instructions.

Figure 20. Sample radiation hazard card.

TRAFFIC CONTROL INSTRUCTIONS

THIS ACCIDENT MAY HAVE CAUSED RADIOACTIVE CONTAMINATION IN THE LOCAL AREA. YOU ARE REQUESTED TO DETOUR AROUND THIS AREA. IF YOU PROCEED AT YOUR OWN RISK:

1. Keep all windows and vents closed.
2. Proceed without stopping.
3. Wash vehicle thoroughly at first opportunity.

Figure 21. Sample, traffic control card.

c. *Contamination Control.* Every effort should be exerted to contain the contamination within a localized area. Personnel and animals should be evacuated from the area suspected of contamination as expeditiously as possible. Evacuation of personnel and area control may be expedited by use of card handouts such as those shown in figures 20 and 21. They may be printed on 3- by 5-inch cards, using red lettering.

- (1) Personnel leaving and animals and equipment being removed from any contaminated area will be monitored at the control station to minimize spread of contamination. Movement within a contaminated area should be reduced to a minimum.
- (2) Controls will be established so that the total dose from all sources of nuclear radiation received by an indi-

vidual will not exceed the dose established by Title 10, Code of Federal Regulations, Part 20. A film badge and two self-reading dosimeters will be worn by all personnel entering the area. Procedures will be established to prevent the inhalation and ingestion of radioactive particles. For the purpose of rescuing injured personnel, these requirements may be waived in emergencies.

- (3) Decontamination stations should be located at the exit points adjacent to the control stations so that decon-

tamination can be supervised by the Alpha Team or the RADCON Team.

- (4) Radioactive waste should be controlled and placed in temporary storage pending receipt of final disposition instructions from Commanding Officer, Edgewood Arsenal, Md. Whenever possible, contamination at safe levels should be fixed permanently to preclude resuspension (sec X).
- (5) Air sampling stations should be established downwind to determine possible airborne concentration of radio activity (para 33).

SECTION XII

RADIOACTIVE WASTE DISPOSAL

57. General

Radioactive waste includes any material which is radioactive, or which is contaminated with radioactive material, and which is no longer of use to the possessing agency.

58. Classification of Radioactive Waste

One method of classifying radioactive waste is by physical form.

a. Solid Waste. Solid waste includes such material as contaminated equipment and contaminated trash (to include surface layer of ground contaminated from a nuclear accident).

b. Liquid Waste. Liquid waste will usually be of low level contamination and may be produced in large amounts from decontamination operations and some laboratory operations. With proper dilution as outlined in Title 10, Code of Federal Regulations, Part 20, liquid contamination may be disposed of in a sewerage system.

c. Gaseous Waste. Gaseous waste normally will not require decontamination and disposal as it will be diluted by dispersion in the air.

59. Responsibilities

a. The Surgeon General is responsible for prescribing conditions under which disposal of radioactive waste material is authorized (AR 755-380).

b. The Commanding Officer, Edgewood Arsenal, Md., is responsible for exercising staff supervision over all matters pertaining to the disposal of radioactive material within the Department of the Army.

c. Installation and activity commanders having radioactive material for disposal are responsible for providing adequate security,

storage, and monitoring services. For detailed instructions refer to AR 755-380, TM 3-220, TM 3-260, and TM 5-225.

60. Packaging, Labeling, and Shipping Radioactive Waste

a. Packaging Instructions.

- (1) Returnable amounts of source and special (SS) nuclear material from special weapons will be packaged for surface movement, labeled, and shipped in accordance with instructions in TM 39-20-6.
- (2) Radioactive waste such as paper, clothing, and dirt contaminated from a nuclear accident will be packaged for surface movement, labeled, and shipped to a radioactive material disposal facility for ultimate disposal. The radioactive waste normally will consist of large amounts of dirt and other material and will be packaged in accordance with Interstate Commerce Commission (ICC) (Title 49, Code of Federal Regulations, Parts 71 and 78) regulations so far as possible. If ICC regulations cannot be complied with, application should be made to the Commanding Officer, Edgewood Arsenal, Md., for special permit and provision of escort.
- (a) Radioactive materials that present special hazards because they tend to remain fixed in the human body for long periods of time (radium, plutonium, strontium, etc.) must be packed inside metal containers. The design and preparation of the package must be such that there will be no significant radioactive surface

contamination of any part of the container.

- (b) All outside shipping containers must be of such design that beta-gamma radiation will not exceed 200 mrad/hr at any point of readily accessible surface. Containers may be equipped with handling devices when necessary.
- (c) To meet the above requirements, 55-gallon drums or garbage cans may be used if provision is made for sealing the containers prior to shipment for ultimate disposal. One method of sealing is to place a layer of concrete inside the can or drum. This may be done by using a mold in which to pour concrete. The concrete should be from 2.5 to 5 centimeters (1 to 2 inches) thick on the

top, bottom, and sides of the container. The concrete will probably provide enough shielding to reduce the dose rate on the container surface below 200 mrad/hr.

b. Labeling Instructions. When radioactive material is shipped by common carrier, labeling will conform to regulations of the ICC or other applicable regulatory body. In addition, labeling will conform to the provisions of AR 55-55 and AR 755-380.

c. Shipping Instructions. Shipping instructions will be requested from Commanding Officer, ATTN: Depot Operation Division, Edgewood Arsenal, Md.

d. Air or Water Shipments. Air or water shipments of radioactive waste should be made in accordance with AR 55-55.

APPENDIX I

REFERENCES

1. Department of the Army Publications

AR 15-22	Nuclear Weapon Accident Investigation Board (CONUS)
AR 40-13	Radiological Emergency Medical Teams
AR 40-14	Control and Recording Procedures: Occupational Exposure to Ionizing Radiation
AR 55-55	Transportation of Radioactive and Fissile Materials Other Than Weapons
AR 55-203	Movements of Nuclear Components and Nuclear Weapons Material
AR 75-15	Responsibilities and Procedures for Explosive Ordnance Disposal
AR 95-55	Nuclear Weapon Jettison
AR 190-60	Physical Security Standards for Nuclear Weapons
AR 220-58	Organization and Training for Chemical, Biological, and Radiological Operations
AR 320-5	Dictionary of United States Army Terms
AR 320-50	Authorized Abbreviations and Brevity Codes
AR 360-5	General Policies
AR 360-43	Information Guidance, Nuclear Accidents and Nuclear Incidents
AR 360-65	Establishment and Conduct of Field Press Censorship in Combat Areas
AR 360-80	Release of Information When More Than One Service is Involved in Accidents or Incidents
AR 385-30	Safety Color Code Markings and Signs
AR 385-40	Accident Reporting and Records
AR 580-15	Security Requirements for Nuclear Weapons
AR 700-52	Licensing and Control of Radioactive Materials
AR 700-65	Nuclear Weapons and Nuclear Weapons Materiel
AR 715-30	Local Purchase of Civilian-Type Items
AR 755-14	Responsibilities for Explosive Ordnance Disposal
AR 755-380	Disposal of Unwanted Radioactive Material
FM 3-8	Chemical Corps Reference Handbook
FM 3-12	Operational Aspects of Radiological Defense
TM 3-210	Fallout Prediction
TM 3-220	Chemical, Biological, and Radiological (CBR) Decontamination
TM 3-260	Operation of Radioactive Material Disposal Facilities
TM 3-500	Chemical Corps Equipment Data Sheets
TM 5-225	Radiological and Disaster Recovery at Fixed Military Installations
TM 5-315	Firefighting (Structures and Aircraft) and Rescue Operations in Theaters of Operations
TM 9-1300-206	Care, Handling, Preservation, and Destruction of Ammunition
TM 11-6665-207-12	Operation and Organizational Maintenance: Radiac Set AN/PDR-53
TM 11-6665-208-15	Operator's Organizational Field and Depot Maintenance: Radiac Set AN/PDR-54

TM 11-6665-209-15 Operator, Organizational, Field and Depot Maintenance Manual: Radiac Set AN/PDR-27J

TM 11-6665-213-12 Operator and Organizational Maintenance Manual: Radiacmeter IM-174/PD

TM 11-6665-214-10 Operator's Manual: Radiacmeters IM-93/UD, IM-93A/UD, and IM-147/PD

TM 11-6665-221-15 Organizational, DS, GS, and Depot Maintenance Manual: Radiac Set AN/PDR-60 (PAC-1SAGA)

TM 38-750 Army Equipment Records Procedures

TM 39-20-6 Disposal of Radioactive Waste

TB 3-6665-202-12 Calibrator, Radiac, TS-1230A

TB 3-6665-203-12 Calibrator, Radiac, AN/UDM-6

TB CML 79 Water Testing Kit, Poisons, M4A1

TB SIG 226-8 Chargers, Radiac Detector PP-1578/PD and PP-1578A/PD

TB SIG 226-9 Field Expedient for Charging Radiacmeters IM-93/UD and IM-147/PD

SB 11-206 Film Badge (Photodosimetry) Supply and Service for Technical Radiation Exposure Control

TA 50-914 Individual Safety and Protective Clothing and Equipment

2. Other Publications

a. These publications are available by purchase from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. Requests should be submitted through local supply channels under the provisions of AR 715-30.

- (1) Handbook of Federal Regulations, Transportation of Radioactive Materials, May 1958.
- (2) Title 10, Code of Federal Regulations, Part 20, Standards for Protection Against Radiation.
- (3) Title 49, Code of Federal Regulations, Parts 71 and 78, Packaging, Labeling, and Transportation of Dangerous Articles.
- (4) National Bureau of Standards (NBS) Handbooks:
 - (a) No. 51, Radiological Monitoring Methods and Instruments.

- (b) No. 65, Safe Handling of Bodies Containing Radioactive Isotopes.
 - (c) No. 69, Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and in Water for Occupational Exposure.
 - (d) No. 92, Safe Handling of Radioactive Materials.
 - (5) Joint Department of the Army, Navy, Air Force, and Atomic Energy Commission Agreement of General Areas of Responsibility and Procedures Applicable to the Prompt, Effective, and Coordinated Response to Accidents Involving Nuclear Weapons, 27 February 1958.
 - (6) Interagency Radiological Assistance Plan, July 1961, U.S. Dept. of Health, Education and Welfare.
- b. Appropriate Nuclear Accident and Incident Control Plan (NAICP), army area basic plan, or ARADCOM NAICP.

APPENDIX II

SAMPLE SOP OUTLINE

(Classification)

Headquarters
Location
Date

ANNEX _____ (ALPHA TEAM) TO NUCLEAR ACCIDENT CONTAMINATION CONTROL SOP

1. GENERAL

The purpose of this annex is to standardize normal procedures for minimizing the possible hazardous effects of radioactive contamination caused by a nuclear accident and for performing expeditious decontamination of an accident site if required.

2. REFERENCES

- a. FM 3-15, Nuclear Accident Contamination Control.
- b. Appropriate Nuclear Accident and Incident Control Plan (NAICP), army area basic plan, or ARADCOM NAICP.
- c. TA 50-914, Individual Safety and Protective Clothing and Equipment.

3. DEFINITIONS

- a. Standby team—status when the team leader is notified that a weapon shipment is in progress.
- b. Alerted team—status when the team leader is notified that an accident has occurred.
- c. Army Area Representative (AAR)—a designated senior officer who, by knowledge and experience, is capable of making rapid and vital decisions and recommendations necessary to prevent or minimize the hazardous effects that can result from a nuclear accident.
- d. Alpha Team—a CBR team with the additional capability and responsibility for alpha monitoring. The team is also capable of limited personnel decontamination.
- e. RADCON Team—Radiological Control Team.

(Classification)

4. DUTIES AND RESPONSIBILITIES

a. Team leader will—

- (1) Prepare and maintain up-to-date informational roster of all team members.
- (2) Insure that each team member is aware of his assigned duties and is properly trained.
- (3) Prepare a checklist to insure that the team on alert status can assemble, load equipment, and prepare to move out within 30 minutes during duty hours and within 1 hour during off-duty hours.
- (4) Inform the AAR the nature of the hazard upon arrival at the accident site and assist in controlling the spread of contamination.

b. Assistant team leader will assist the team leader and assume control if necessary.

c. Monitors will be capable of performing alpha and beta-gamma monitoring and survey procedures.

d. Each team member will be trained in his assigned duties as well as the duties of all other members so in the event one member is unable to participate for any reason any other member is sufficiently trained to perform his duties.

5. WARNING SYSTEM

The Alpha Team will be notified to "stand by" when the movement of a nuclear weapon is scheduled. In the event of an accident, this team will be "alerted" for movement to the accident site.

6. CAPABILITIES

The Alpha Team will be capable of—

- a. Performing alpha and beta-gamma radiation monitoring.
- b. Performing alpha and beta-gamma radiation surveys.
- c. Supervising personnel and equipment decontamination.
- d. Providing guidance to the AAR on contamination control.
- e. Assisting the RADCON Team as required.

7. PROCEDURES

The Alpha Team will determine the presence or absence of radiological contamination. This determination must be made regardless of accident type.

(Classification)

- a. Locate and mark the approximate perimeter of the contaminated area, using the following conditions as a guide for establishing the extent of the area:
 - (1) If significant beta-gamma radiation is present, mark the general location of the 10 mrad ~~contour~~ line.
 - (2) If alpha contamination is present, mark the general location of the 1,000 ~~μCi~~ $\text{Pu}^{239}/\text{Pu}^{240}$ on line.
 - (3) If both alpha and gamma radiation are detected, the exclusion perimeter may be a combination of contours determined as (1) and (2) above, using the contour farthest from the actual site of the accident.
- b. Film badges and pocket dosimeters will be utilized at the accident site to control exposures to beta-gamma radiation.
- c. Control will be established so that the total dose received by any individual exposed during recovery operations will not exceed 1.25 rem per calendar quarter from all sources of nuclear radiation. However, a larger dose may be permitted in order to save lives.
- d. After operating at the site of a nuclear accident, persons will report to their servicing medical facility for evaluation of possible internal radiological contamination.

8. PROTECTION

Personnel engaged in the initial area monitoring will wear respiratory protection, coveralls, gloves, surgeon's cap, and boot covers until the radiological contamination situation has been determined.

9. DECONTAMINATION

Only expedient emergency-type personnel decontamination will be performed unless directed by the AAR.

- a. Personnel. Contamination should be kept as low as possible. Persons leaving the contaminated area will be monitored; decontamination will be required whenever contamination is found on skin or clothing.
 - (1) Members of the military services will be required to decontaminate themselves.
 - (2) Civilians who are contaminated will be advised to remove clothing and place the contaminated clothing in a bag for decontamination. They should then shower and return for further monitoring. If no contamination is found, they should put on clean clothing.
- b. Equipment. Vehicle and other equipment contamination must be reduced to less than 0.4 mrad/hr (beta-gamma) and 4 dpm/cm²

(Classification)

(Classification)

(alpha) fixed. Respiratory protective devices will not be used if the contamination level of these devices is greater than 1.0 mrad/hr (beta-gamma) or 2 dpm/cm² (alpha).

- c. Area and Buildings. The RADCON Team will supervise necessary decontamination.

10. SUPPLY

The Alpha Team will be equipped to perform its mission and will be provided necessary protective clothing and equipment in accordance with TA 50-914.

11. TRAINING

All team members will be trained in alpha and beta-gamma monitoring.

- a. Cross-training and periodic training in depth will be conducted to insure capability for performance of the team's mission.
- b. Periodic practice alerts will be conducted to maintain readiness. These tests will consist of assembling the team and its equipment, moving to the site of a simulated accident, and conducting a survey.

12. RECORDS AND REPORTS

Operational and administrative records will be maintained and reports will be submitted as required. Area maps and overlays will be kept current and the chronological sequence of events will be logged.

OFFICIAL:

Command Line

(Classification)

By Order of the Secretary of the Army:

HAROLD K. JOHNSON,
General, United States Army,
Chief of Staff.

Official:

J. C. LAMBERT,
Major General, United States Army,
The Adjutant General.

Distribution:

Active Army:

DCSPER (2)
DCSLOG (2)
DCSOPS (2)
ACSI (2)
ACSFOR (2)
DASA (2)
CRD (1)
CORC (2)
TAG (2)
COA (1)
CINFO (1)
TIG (1)
TJAG (1)
CNGB (2)
TSG (2)
TPMG (2)
USCONARC (5)
USACDC (2)
USACDCTA (1)
USACDCCBRA (3)
USACDCEA (2)
USACDCNG (1)
ARADCOM (2)
ARADCOM Rgn (2)

LOGCOMD (1)
USA Nuclear Def Lab (25)
Armies (5) except
 Third (35)
MDW (2)
Corps (3)
USAC (2)
Div (2)
Div Arty (1)
Bde (1)
Regt/Gp/Bat Gp (1)
Bn (1)
Co/Btry (1)
Instl (3) except
 Edgewood Ars (6)
Svc Colleges (2)
Br Svc Sch (2) except
 Msl Mun Cen and Sch (25)
 USAOCS (5) USASCS (7)
 USASESCS (20) USATSCH (10)
 MFSS (30) USAMPS (15)
USACBRWOC (2)
Units org under fol TOE:
 17-22 (1)

NG: State AG (3) Units same as active Army except allowance is one copy each unit.

USAR: Same as active Army except allowance is one copy each unit.

For explanation of abbreviations used, see AR 320-50.

☆ U.S. Government Printing Office: 1966—200-511/7092A



118 Rev-75

FM 3-15
C 1

CHANGE }
No. 1 }

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 5 October 1967

NUCLEAR ACCIDENT CONTAMINATION CONTROL

FM 3-15, 17 June 1966, is changed as follows:

"550 meters" is changed to read "450 meters" in the following places:

Page 30, paragraph 33a, line 8.

Page 34, figure 10.

Page 35, figure 11.

Page 40, paragraph 44a, lines 4, 10, 16, 18, and 12.

Page 57, paragraph 56a(1), line 10.

Page 40, paragraph 44a, in line 4 "(1,800 feet)" is changed to read "(1,500 feet)."

"Army Area Representative" is changed to read "Nuclear Accident Incident Control Officer" in the following places:

Page 4, paragraph 4c, line 5.

Page 56, paragraph 55a, line 4.

Page 63, paragraph 3c, line 1.

"AAR" is changed to read "NAICO" in the following places:

Page 4, paragraph 4c, lines 5, 8, and 15, and paragraph 4d, line 8.

Page 9, paragraph 11b, line 3, and 11g, line 2.

Page 10, paragraph 15b, lines 2, 11, 13, and 15, and paragraph 15d, line 2.

Page 11, paragraph 16, line 3.

Page 11, paragraph 17f, line 1.

Page 11, paragraph 18a, line 9.

Page 16, paragraph 19, line 4.

Page 19, table II, footnote 4.

Page 19, paragraph 21a, lines 10 and 24.

Page 19, paragraph 21a(1), line 3 and 21c, line 2.

Page 40, paragraph 43, line 7.

Page 41, paragraph 44b(2), line 2 and 44b(3), lines 4, 7, and 17.

Page 43, paragraph 46a, line 4.

Page 56, paragraph 55d, line 5.

Page 56, paragraph 56, line 2.

Page 57, paragraph 56a, line 7 and 56b(2), line 10.

Page 63, paragraph 3c, line 1.

Page 64, paragraph 4a(4), line 1.

Page 64, paragraph 6d, line 1.

Page 65, paragraph 9, line 2.

Page 40, paragraph 44a. The last sentence, beginning in line 10, page 41, is deleted and the following sentences are substituted: "An effort should be made to minimize the electromagnetic environment at the accident site until EOD personnel have established that no electromagnetic radiation hazard exists. Devices that require substantial radiation of electrical power to function, such as radio transmitters, radar sets, and the like, will not be operated within the TRANSMITTER EXCLUSION AREA shown in figure 15.1. This restriction does not apply to electric motors, generators, power-driven equipment, wired telephones, vehicle ignitions, and the like provided they do not come in physical contact with the weapon. Radiating equipment may be used in the TRANSMITTER RESTRICTION AREA (fig. 15.1) provided the weapon is not a missile that has been subjected to a launch environment and the equipment does not radiate a sum total output in excess of 100 watts. If the weapon is a missile which has been subjected to a launch environment, transmitters will not be used within a radius of 3.2 kilometers until such time as the EOD team has performed their render-safe-procedures (RSPs). Upon completion of RSPs, transmitters may be utilized within a 100-meter radius of the accident site."

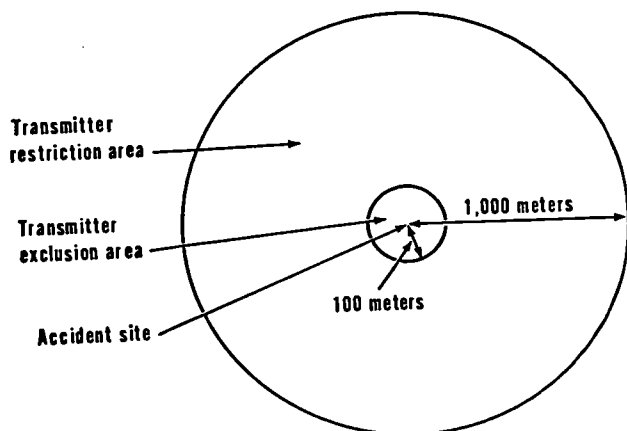


Figure 15.1. Transmitter exclusion and restriction areas.

By Order of the Secretary of the Army:

Official:

KENNETH G. WICKHAM,
Major General, United States Army,
The Adjutant General.

HAROLD K. JOHNSON,
General, United States Army,
Chief of Staff.

Distribution:

To be distributed in accordance with DA Form 12-11 requirements for Nuclear Accident Contamination Control.

Page 61, appendix I.

The following are deleted:

AR 580-15.

AR 755-380.

The following are added:

AR 50-2, Nuclear Weapon Accident and Incident Control (NAIC).

AR 50-3, Personnel Security Standards for Nuclear Capable Organizations and Activities.

AR 755-15, Disposal of Unwanted Radioactive Material.



FM 3-15 NUCLEAR ACCIDENT CONTAMINATION CONTROL—1966